

Trade Liberalization and Industrial Concentration

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Abstract

I examine the interrelationship between industrial concentration, the CES industry price index and imports in trade liberalization events. I develop a hybrid model that augments the standard monopolistic competition approach in the international trade literature to include an oligopolistic margin: a set of foreign and domestic heterogeneous granular firms competing in quantities. This margin predicts novel effects of trade liberalization on consumer welfare, industrial concentration, and imports. Specifically, trade liberalization generates (i) lower consumer gains when foreign firms are more concentrated than domestic, (ii) higher domestic industrial concentration, and (iii) lower imports when the foreign oligopoly margin is larger. I test the novel oligopolistic margin using diff-in-diff variation from discriminatory trade policy in Colombia. I find robust evidence for this margin and show that the aggregate impact of both trade liberalization and discriminatory trade policy can be substantially reduced by oligopolistic behavior. Moreover, foreign concentration heterogeneity across origin countries suggests a highly heterogeneous impact of trade liberalization: imports from countries in the top decile of concentration had 13 log points lower growth on average than imports from countries in the bottom decile.

Keywords: Trade Liberalization, Industrial Concentration, Gravity Equation, Market Power, Oligopoly, Discriminatory Trade Policy

JEL codes: F12, F13, F14, F15, L11, L13

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1 Introduction

In recent years, interest in industrial concentration has been fueled by evidence showing an increase in this measure in the US, Japan and European countries (OECD, 2018, Bajgar et al., 2019).¹ Over the same period of time, the decrease in trade barriers has made competition between domestic and foreign firms a more common feature of markets. In this paper, I propose a theory that establishes a link between industrial concentration, competition and trade policy.

Large firms dominate international trade.² It has been shown that the top five exporters account for an average of about 30% of country exports and explain about half of its variation in developing countries (Freund and Pierola, 2015); whereas the top decile accounts for an 95% of total exports in average in the US (Bernard et al., 2018), and an average of 87% in European countries (Mayer and Ottaviano, 2008).³ Despite this evidence, standard trade models with heterogeneous firms leave little room for the role of large firms in their mechanism through which changes in trade costs affect trade flows and consumer welfare.⁴ Given that, I investigate a channel through which large firms can differ: their oligopolistic behavior.⁵

I examine the interrelation between industrial concentration, the CES industry price index and imports when tariffs decrease. I extend the standard model of international trade in which monopolistically competitive firms with heterogeneous productivity produce differentiated varieties by adding a set of more productive granular firms. These origin-specific large firms sell their varieties in the domestic market and take the impact of their decisions on industry aggregates into account.⁶ This model allows me to identify a novel channel through which trade liberalization affects competition: I find that relative industrial concentration between domestic and foreign firms matters in determining the total impact of trade liberalization on the industry price index. When domestic firms are relatively more concentrated, a tariff reduction shifts demand towards the less concentrated, lower aggregate markup segment of the market, magnifying the impact of tariffs on the price index. Moreover, the model also allows me to study how trade liberalization affects domestic concentration. I formally show that trade liberalization increases domestic concentration if oligopolistic domestic firms have a higher market share than monopolistic competitive domestic firms. In this sense, an increase in domestic concentration can be a sign of more, not less competition.

¹In the case of the US, the rise in the relative importance of large firms has been associated with other secular trends such as the decline in the labor share of income and the rise of superstar firms (Autor et al., 2017; Autor et al., 2019), the decrease in domestic competition and investment (Gutierrez and Philippon, 2018, Grullon et al., 2019), and the rise of markups (De Loecker et al., 2020).

²I use the terms “large” and “granular” interchangeably, and the term “small” for nongranular firms throughout the paper.

³Freund and Pierola (2015) employ the Export Dynamic Database (EDD), a World Bank database that included 32 developing countries at the time they published the paper.

⁴Head and Spencer (2017) show that the share of papers published in the top field journal (JIE) mentioning “monopolistic competition” and “heterogeneous firms”, two features of the standard model, surged in the 2000s and continued increasing in the 2010s. On the contrary, papers mentioning “oligopoly” continuously decreased since the 1990s. However, the authors identify a promising resurgence of oligopoly models in the last years.

⁵Even though observing that large firms charge higher markups than small firms is not sufficient to conclude they are behaving in an oligopolistic fashion, there is substantial empirical evidence showing that the distribution of markups is positively skewed (De Loecker et al., 2016; De Loecker et al., 2020), and firms price to market (Atkeson and Burstein, 2008). These two features suggest oligopolistic behavior.

⁶The workhorse model with heterogeneous firms was introduced by Melitz (2003) and modified by Chaney (2008) to focus on the gravity equation implications. In this paper I focus on the industry level version of this model where I take income as given.

I exploit the hybrid structure of the model to derive a novel oligopoly-augmented gravity equation in changes. I show that the first-order impact of a change in tariffs on trade flows is lower when exporter-specific granular firms are more concentrated and have a larger market share in the importing country. This finding makes explicit that structural gravity equations derived from monopolistic competitive models are misspecified when there is oligopolistic behavior.

I empirically study the heterogeneous first-order impact of trade policy through the differential market power of large firms. I study recent changes in Colombia’s discriminatory trade policy among members of the World Trade Organization (WTO). In the 2010-2013 period, Colombia decreased its Most Favored Nation (MFN) tariffs and signed its first Free Trade Agreements (FTA) with developed countries.⁷ I exploit industry and country variation arising from that differential treatment to identify both the elasticity of imports with respect to trade costs, i.e. the trade elasticity, and the *oligopolistic margin*, the extra channel introduced by granular firms. Using the theory-based industrial concentration measure that captures the differential pass-through across exporters, I find that the oligopolistic margin effectively reduced the magnitude of the trade elasticity. In the preferred specification, one standard deviation increase in the theory-based concentration measure reduces the trade elasticity by 55%.

The novel oligopolistic margin suggests that the actual impact of tariffs on imports is highly heterogeneous across exporters and depends on their initial concentration. I find that the aggregate effect of trade liberalization is lower than the average effect due to the oligopolistic margin, illustrating that this channel can have important implications for the aggregate first-order impact of trade liberalization. I also find that the additional decrease in tariffs due to newly signed FTAs had no differential impact on aggregate imports from their members due to their higher initial concentration levels. To further investigate the importance of concentration, I estimate that imports from countries at the top decile in terms of firm concentration had 13 log point lower average growth than imports from countries at the bottom decile over a period of time in which imports grew 36 log points on average in Colombia. Therefore, policymakers should consider the market structure of foreign exporters when proposing changes to trade policy.

I contribute to understanding the role of industrial concentration in international trade when large firms have oligopolistic behavior. Industrial concentration does not have a distortive role at the industry level when consumers have CES preferences and firms are monopolistically competitive (cf. Dhingra and Morrow, 2019). Therefore, models covered by the seminal Arkolakis et al. (2012) provide no insights in this regard given that concentration indices do not contain any additional information. Arkolakis et al. (2018) depart from CES preferences to allow for variable markups, but they assume away the role of market structure in welfare.⁸ My model allows for both distortive and non-distortive firm behavior and stresses the importance of specific differences in the realized productivity distributions of large firms across their origins to characterize the impact of changes in import prices on consumer gains and competition.⁹

⁷Canada (2011), US (2012), and the European Union (2013).

⁸They assume monopolistic competition and a common unbounded Pareto distribution for firms’ productivities across countries.

⁹The theoretical role of industrial concentration in international trade models depends on how consumers preferences, com-

I contribute to the understanding of the gravity equation in the context of structural models. Anderson (1979) was the first to propose a theoretical framing of the gravity equation. However, Anderson and van Wincoop (2003) were the first to provide a general equilibrium model to recover fundamental parameters. Recently, many papers followed their approach and found settings under which a broad spectrum of general equilibrium models can microfound the gravity equation (cf. Allen et al., 2020). My model abstracts from general equilibrium effects to focus on industry characteristics, which allows me to study the impact of market structure at the level at which tariffs are usually determined. Even though introducing oligopolistic behavior prevents me from finding exact changes, the first order impact of trade costs allows me to characterize the way oligopolistic behavior affects bilateral trade around the equilibrium.

There is an extensive empirical literature employing gravity equations to study the impact of trade policy on bilateral trade. Some papers study the econometric issues that arise when studying the impact of policy, such as Baier and Bergstrand (2007); whereas other papers focus on the channels through which policy affects different trade margins, such as Baier et al. (2014). I argue that the diff-in-diff empirical strategy I exploit provides exogenous variation that overcomes the common issues of studying endogenous trade policy and allows me to identify the aforementioned oligopolistic margin.

To the best of my knowledge, Parenti (2018) was the first to construct an international trade model in which small and large firms compete.¹⁰ My model differs from his in two key aspects. First, I assume firm heterogeneity within and across groups of firms and therefore I am able to nest standard industry trade models with a continuum of heterogeneous firms. Specifically, my model can be understood as an extension of Melitz and Redding (2015), which features heterogeneous small firms and bounded Pareto productivity distribution but no firm granularity. Therefore, I contribute to the existing literature by adding an extra margin of adjustment in trade capturing market power. Second, Parenti (2018) assumes that large firms can decide both prices and the number of products they produce and therefore his setting is richer along that dimension.¹¹ Finally, the focus of his paper is different too. In my case, I focus on the role of industrial concentration in international trade, showing that it can capture markup responses and be affected by competition in a setting with firm turnover. Parenti (2018) focuses on how trade liberalization conclusions can differ from other papers with homogeneous firms such as Krugman (1979) due to granularity.

I also contribute to the body of papers that allows for oligopolistic behavior in international trade models. Head and Spencer (2017) argue for the importance of accounting for large firms given the aforementioned evidence and the fact that they can modify theoretical and empirical predictions. Edmond et al. (2015) study the impact of trade liberalization on welfare by using a oligopolistic model with heterogeneous firms.¹²

petition and firms' productivity distributions are modeled. Another paper in which concentration has a specific interpretation is Feenstra and Weinstein (2018), in which lower firm concentration is associated with lower welfare gains due to a more crowded product space.

¹⁰Shimomura and Thisse (2012) were the first to construct a hybrid model where homogeneous large and small firms interact but in a closed economy.

¹¹My model can be extended to allow large firms to be multiproduct. Given that both large and small firms are heterogeneous in my model, conclusions may differ from Parenti (2018). I leave this extension for future research.

¹²Other relevant questions that were already addressed are how oligopolistic firms can influence aggregate trade flows (Eaton et al., 2012), the exchange rate pass-through (Amiti et al., 2014; Auer and Schoenle, 2015), the comparative advantage of

Even though the underlying mechanism in the case of large firms is the same, my model allows for the inclusion of entry of small firms as in standard models of trade with monopolistic competition. Given the long tail of small firms usually observed in trade data and the relatively lower exit probability of large firms, I argue that constructing a hybrid model can help both in addressing the differential market power of large firms and in solving the technical limitations imposed by oligopoly models (cf. Neary, 2016).¹³ Moreover, the focus of this paper is not to quantify the gains from trade under misallocation as it was theirs, but rather to identify and characterize the specific role of large firms in the impact of tariffs on both the CES price index and concentration.

In Section 2, I develop the theory and present the main theoretical results. In Section 3, I derive an oligopoly-augmented gravity equation and present the empirical application. Section 4 concludes.

2 A Theory of Hybrid Competition in International Trade

In this section, I develop the theory focusing on the role of firm concentration and its relationship with the standard international trade model with heterogeneous firms at the industry level.

2.1 Model

2.1.1 Environment

In a given industry, there are an exogenous number of domestic and foreign active firms, N_d^l and N_f^l respectively, that decide the optimal quantity they produce of different varieties of a good. These firms are granular, so they acknowledge the impact of their choices on industry aggregates, and heterogeneous in their productivity. There is also a continuum of domestic and foreign small firms in the industry. Foreign firms face an ad-valorem tariff τ in the domestic economy, so the price they receive is p/τ . In addition, these firms face an ad-valorem unit cost T_f that captures transport costs and input prices employed by foreign producers. Domestic firms face an ad-valorem unit cost T_d .

2.1.2 Consumer Preferences

Consumers have CES preferences with elasticity of substitution $\sigma > 1$, which is the same across all varieties, regardless of being produced by small or large firms; and spend an exogenous amount E on the industry. Therefore, the utility function is as follows:

$$Q = \left[(Q_d^s)^{\frac{\sigma-1}{\sigma}} + (Q_d^l)^{\frac{\sigma-1}{\sigma}} + (Q_f^s)^{\frac{\sigma-1}{\sigma}} + (Q_f^l)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (1)$$

countries (Gaubert and Itshoki, 2018), and the strategic complementarities between foreign and domestic firms (Amiti et al., 2019).

¹³Eaton et al. (2007) show that Colombian exporters in the top quintile at t have a probability of 90% of continuing exporting at $t + 1$. This probability decreases monotonically towards the fifth quintile, where exporters at t only have a probability of 24% of surviving at $t + 1$.

where subscripts index origin (foreign or domestic), superscripts index type of firms (large or small), and Q s are the composite goods indicated by the superscripts and subscripts (e.g. Q_f^l is the composite good of large foreign firms). We have that $Q_f^s = \left[\int_{\Omega_f^s} [q_f^s(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$ in the case of small foreign firms where Ω_f^s is the set of domestic available varieties (and analogously for small domestic firms); and $Q_f^l = \left[\sum_{i=1}^{N_f^l} [q_{f,i}^l]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$ in the case of large foreign firms (and analogously for large domestic firms).¹⁴ The industry price index has the standard CES expression:

$$P = \left[(P_d^s)^{1-\sigma} + (P_d^l)^{1-\sigma} + (P_f^s)^{1-\sigma} + (P_f^l)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad (2)$$

where $P_f^s = \left[\int_{\Omega_f^s} [p_f^s(\omega)]^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$ in the case of small foreign firms; and $P_f^l = \left[\sum_{i=1}^{N_f^l} [p_{f,i}^l]^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$ in the case of large foreign firms. All firms face the inverse demand function $p_{f,i} = (q_{f,i})^{-\frac{1}{\sigma}} Q^{\frac{1-\sigma}{\sigma}} E$ regardless of their type.

2.1.3 Small Firms

Small firms do not affect industry aggregates individually and charge the fixed markup $\tilde{\mu} \equiv \frac{\sigma}{\sigma-1}$. They decide whether to enter into the domestic economy by comparing the present discounting value of profits to the sunk cost of entry K . The marginal foreign firm entering into the market will equate these two:

$$\frac{\pi_{f,*}^s}{1-\beta} = K \quad (3)$$

where $\pi_{f,*}^s \equiv \tilde{\sigma} \tau^{-\sigma} (c_{f,*}^s)^{1-\sigma} \left(\frac{P}{T_f} \right)^{\sigma-1} E$, and $\beta < 1$ is the exogenous probability of exit.¹⁵ The zero cutoff profit cost $c_{f,*}^s$ captures the expression:

$$c_{f,*}^s = \frac{P}{T_f} \left[\frac{\tilde{\sigma} E}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \tau^{-\frac{\sigma}{\sigma-1}} \quad (4)$$

I assume that small firms draw unit costs from a bounded Pareto distribution $G^s(c^s) = \frac{(c^s)^k - (c_L^s)^k}{(c_H^s)^k - (c_L^s)^k}$ where $1/c_H^s$ is the lower productivity bound, $1/c_L^s$ is the upper productivity bound, and k is the shape parameter. In order to provide rationale for the coexistence of large and small firms, I assume that the upper productivity bound is smaller than the least productive large firm.¹⁶ As a result, large firms cannot be less productive than small firms.¹⁷

Finally, note that domestic expressions are the same but with $\tau = 1$.

¹⁴I present expressions for foreign firms without loss of generality.

¹⁵ $\tilde{\sigma} \equiv (\sigma-1)^{\sigma-1} \sigma^{-\sigma}$

¹⁶If I order large firms unit costs' in descending order, this assumption implies that $c_L^s > c_{f,1}^l$.

¹⁷This suggests the following rationalization: ex-ante, firms decide to enter based on the bounded Pareto distribution. However, there is a sufficiently low probability of becoming granular and receiving a higher productivity. Since the probability of this event is close to zero, small firms do not consider that when comparing expected profits to the sunk cost of entry.

2.1.4 Large Firms

Domestic and foreign large firms have an arbitrary distribution of unit costs, $\{c_{d,i}\}_{i=1}^{N_d}$ and $\{c_{f,i}\}_{i=1}^{N_f}$ respectively.¹⁸ All large firms compete in quantities, which means that they decide the optimal level of production by also taking into account how they impact the aggregate quantity index Q . Therefore, the first-order condition of a large foreign firm is as follows:¹⁹

$$p_{f,i}^l - c_{f,i}^l \tau T_f = \frac{1}{\sigma} p_{f,i}^l + \frac{\sigma - 1}{\sigma} s_{f,i}^l p_{f,i}^l \quad (5)$$

where the domestic expression is analogous. On the left hand side we can observe the standard marginal gain of increasing the quantity produced since it is the difference between the market price $p_{f,i}^l$ and the effective unit cost. The first term on the right hand side captures the marginal cost of increasing the quantity produced since doing so generates a movement along the demand curve that decreases the price, a mechanism that is also present in the case of small firms. However, large firms recognize that by increasing quantity, they are also increasing the quantity index and thus reducing the industry price index. This increases competition and pushes prices further down. This is captured by the extra term, $s_{f,i}^l p_{f,i}^l = (q_{f,i}^l)^{\frac{\sigma-2}{\sigma}} / Q^{\frac{\sigma-1}{\sigma}}$, which shows that increasing q increases the marginal cost of choosing a higher quantity relative to monopolistic competition the higher the σ .²⁰ This means that large firms produce less relative to a monopolistically competitive setting the more productive they are because the marginal cost of doing so increases with the market share.²¹

The optimality condition captured by equation 5 delivers the following firm-specific optimal markup:

$$\mu_{f,i}^l = \tilde{\mu} \times (1 - s_{f,i}^l)^{-1} \quad (6)$$

where $\tilde{\mu} \equiv \frac{\sigma}{\sigma-1}$ is the markup that the firm would charge under monopolistic competition.²² Therefore, this model of competition delivers a variable markup that increases with the market share even under CES preferences. The underlying determinant of such market power is the demand elasticity ν the firm perceives, which decreases with its size:²³

$$-\nu_{f,i}^l = (s_{f,i}^l + (1 - s_{f,i}^l)/\sigma)^{-1} \quad (7)$$

¹⁸We can interpret the observed distribution of unit costs as a realization of an unknown productivity distribution where large firms have a technology that allows them to retain such received productivity.

¹⁹Derivation in Appendix A.1.1.

²⁰Note that given the CES demand function $q_{f,i}^l = (p_{f,i}^l)^{-\sigma} P^{\sigma-1} E$, we have that $s_{f,i}^l = (p_{f,i}^l/P)^{1-\sigma} = (q_{f,i}^l/Q)^{\frac{\sigma-1}{\sigma}}$.

²¹This statement is true when $\sigma > 2$, as it is usually the case when this parameter is estimated in the literature.

²²Note that it is the same expression as in Amiti et al. (2019) when the elasticity of substitution across industries is equal to 1 (η in their paper). I assume this elasticity of substitution to focus on the effect of intra-industry and cross-country reallocation of market shares.

²³Assuming price competition delivers similar qualitative predictions.

2.1.5 Industry Equilibrium

Given the fixed distribution of productivities of large foreign and domestic firms, the unit costs shifters, T_d and T_f , the trade policy variable τ_f , the survival probability of small firms β , the sunk cost of entry K , and the distribution of small firms' productivity, G^s , the equilibrium conditions are defined as follows:

$$s_{r,i}^l = (p_{r,i}^l)^{1-\sigma} (P)^{\sigma-1} \quad (8)$$

$$p_{r,i}^l = \tilde{\mu} (1 - s_{r,i}^l)^{-1} \tau_r c_{r,i}^l T_r \quad (9)$$

$$p_r^s(c) = \tilde{\mu} \tau_r c_r^s T_r \quad (10)$$

$$c_{r,*}^s = \frac{P}{T_r} \left[\frac{\tilde{\sigma} E}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \tau_r^{-\frac{\sigma}{\sigma-1}} \quad (11)$$

$$P_r^l = \left[\sum_i^{N_r^l} (p_{r,i}^l)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad (12)$$

$$P_r^s = \left[\int_{c_r^L}^{c_{r,*}^s} (p_{r,i}^s)^{1-\sigma} dG^s(c^s) \right]^{\frac{1}{1-\sigma}} \quad (13)$$

$$P = [(P_d^l)^{1-\sigma} + (P_d^s)^{1-\sigma} + (P_f^l)^{1-\sigma} + (P_f^s)^{1-\sigma}]^{\frac{1}{1-\sigma}} \quad (14)$$

for $r \in (f, d)$ and $i = 1 \dots N_r^l$, where $\tau_d = 1$.

Firms' market shares $s_{r,i}^l$ are defined relative to the entire market. However, we can define the following equilibrium market shares that are useful in subsequent derivations.

Definition 1. Given firm types $\tilde{r} \in \{(d, l), (d, s), (f, l), (f, s)\}$ and the industry equilibrium defined in equations 8-14, the market share of firm i within its type is defined as $z_{\tilde{r},i} \equiv \frac{(p_{\tilde{r},i})^{1-\sigma}}{(P_{\tilde{r}})^{1-\sigma}}$.

Definition 2. Given the industry equilibrium defined in equations 8-14, aggregate equilibrium market shares are defined as:

$$(i) \text{ Share of foreign firms (import penetration): } s_f \equiv \frac{(P_f^l)^{1-\sigma} + (P_f^s)^{1-\sigma}}{P^{1-\sigma}}$$

$$(ii) \text{ Share of large firms: } h^l \equiv \frac{(P_f^l)^{1-\sigma} + (P_d^l)^{1-\sigma}}{P^{1-\sigma}}$$

$$(iii) \text{ Share of } r \text{ firms within large firms: } s_r^l \equiv \frac{(P_r^l)^{1-\sigma}}{(P_d^l)^{1-\sigma} + (P_f^l)^{1-\sigma}}$$

$$(iv) \text{ Share of large firms within } r \text{ firms: } h_r^l \equiv \frac{(P_r^l)^{1-\sigma}}{(P_r^l)^{1-\sigma} + (P_r^s)^{1-\sigma}}$$

where $r \in (f, d)$.

Given definitions 1 and 2, foreign firm i 's overall market share can be written either as $s_{f,i}^l = s_f h_f^l z_{f,i}^l$ or $s_{f,i}^l = h^l s_f^l z_{f,i}^l$.

2.2 Theoretical Results

In this section, I derive the main theoretical results which establish the relationship between industrial concentration, the CES industry price index, and trade liberalization. I first show that large firms' markup responses to competition can be understood as a concentration measure in the aggregate. I then show that trade liberalization decreases the CES industry price index and increases domestic concentration.

In order to do so, I define an increase in competition as follows:

Definition 3. *Any shock that decreases the CES industry price index P is a shock that increases competition.*

In this model, a decrease in P causes both downward pressure on large firms' markups and exit of less-productive small firms. These are two features present in many oligopolistic and monopolistic competitive models that are generally interpreted as characteristics of more competitive environments. Therefore, I use P to capture changes in the state of competition.

2.2.1 Industrial Concentration

Relative Market Shares. In the standard model with a continuum of monopolistically competitive firms, the role of industrial concentration is limited to reflecting the underlying productivity distribution intermediated by the elasticity of substitution conditional on the entry cutoff. Therefore, it is understandable that the international trade literature did not pay much attention to its determinants. With granular firms this is different. Changes in trade costs generate changes in the country-specific distribution of market shares due to firm-specific heterogeneous pass-throughs. Moreover, changes in trade costs do not need to directly affect firms to modify the distribution of shares since changes in competition also affect large domestic firms' markups. Therefore, industrial concentration not only reflects the underlying productivity distribution but also the state of competition in the industry.

Before formalizing the previous discussion, let's first note the following:

$$d \log s_{r,i}^l = (1 - \sigma) d \log(p_{r,i}^l / P) \quad (15)$$

which directly follows from equation 8. This means that a change in the ratio of any exogenous consumer price determinant to the price index is a sufficient statistic for a change in firm-specific overall market share. The reason is that it captures both the direct impact of such effect and the overall change in competition, which aggregates all markup and entry responses, including firm's own.

The previous discussion implies that the effective impact of trade liberalization on individual foreign firms' market shares has to be measured by τ/P in the case of foreign firms, and by $1/P$ in the case of domestic firms (given that there is no direct effect of tariffs on their prices). The following proposition uses this idea to establish the relative response of market shares to trade liberalization.

Proposition 1. *Relative Market Shares Response to Trade Liberalization.* *A decrease in effective*

tariffs, τ/P , that increases competition:

(i) decreases the market share of the relatively more productive large foreign firms,

$$\frac{d \log z_{f,i}^l / z_{f,j}^l}{d \log \tau / P} > 0 \quad (16)$$

where $c_{f,j}^l > c_{f,i}^l$; and

(ii) increases the market share of the relatively more productive large domestic firms,

$$\frac{d \log z_{d,i'}^l / z_{d,j'}^l}{d \log 1/P} > 0 \quad (17)$$

where $c_{d,j'}^l > c_{d,i'}^l$.

Proof: See Appendix A.2.1.

In order to explore the result in Proposition 1, I define the markup pass-through as follows:

$$\psi_{r,i}^l \equiv - \frac{\partial \log \mu_{r,i}^l}{\partial \log p_{r,i}^l} = (\sigma - 1) \frac{s_{r,i}^l}{1 - s_{r,i}^l} \quad (18)$$

where $r \in (f, d)$.²⁴ Note that this elasticity is increasing in firm i market share, which indicates that larger firms react more strongly to changes in either trade costs or competition.²⁵ For instance, a decrease in tariffs leads to higher markup increases by relatively more productive foreign firms and thus lowers their share relative to less productive foreign competitors.²⁶ Domestic firms will face more competition once tariffs go down, and as a result their markups will decrease. The relatively more productive firms will do so at a greater extent and therefore will gain market share.

Concentration Measures. In order to address how industrial concentration relates to the CES industry price index and trade flows, and how trade liberalization affects concentration, we need to have a general definition of industrial concentration as a benchmark.

Definition 4. Given a set of market shares $\{s_i\}_{i=1}^N$, where $\sum_{i=1}^N s_i = S$, a function $\mathcal{C}(\{s_i\}_{i=1}^N) = \sum_{i=1}^N m(s_i)$ is a **proper industrial concentration measure** if a mean-preserving spread, $\mathcal{C}(\{s_i + \Delta_i(s_i)\}_{i=1}^N)$, where $\sum_{i=1}^N \Delta_i = 0$ and $\Delta'_s \geq 0$, increases its value.

²⁴I follow Amiti et al. (2019) in defining a term $\psi_{r,i}^l$ as the negative of the markup elasticity.

²⁵This mechanism is not present in small firms because $\frac{\partial \log \mu_r^s(c)}{\partial \log p_r^s(c)} = 0$.

²⁶The underlying mechanism can be understood by examining equation 5: Even though the decline in tariffs increases the marginal gain of increasing production, a relatively more productive firm i , given its relatively larger size, acknowledges that it need not to increase production as much as less productive firm j to equate those gains to the marginal costs of increasing production. As a result, firm i increases production less than firm j and the decline in $p_{r,i}^l$ is lower than the decline in $p_{f,j}^l$, inducing i 's markup to increase more as a consequence.

Definition 4 is satisfied by most of the widely used concentration measures such as the Herfindahl-Hirschman Index (HHI), the Theil index and the share of top firms when the spread is such that shares are distributed between top and non-top firms.

In order to understand how concentration enters into the model, let's examine how the price index of large foreign firms reacts to changes in competition.

$$\Psi_r^l \equiv \frac{\partial \log P_r^l}{\partial \log P} = \sum_{i=1}^{N_r^l} z_{r,i}^l \frac{\psi_{r,i}^l}{1 + \psi_{r,i}^l} \quad (19)$$

The measure Ψ_r^l is the weighted average of large firms' equilibrium responses to a change in competition. In fact, each firm-specific term $\frac{\psi_{r,i}^l}{1 + \psi_{r,i}^l}$ is the firm-specific equilibrium markup response to changes in determinants of its own prices (e.g. tariff in the case of foreign firms).

The importance of this object for the theoretical implications of the model is captured by the following proposition.

Proposition 2. Large Firms Price Index and Concentration. *The function Ψ_r^l is a proper industrial concentration measure.*

Proof: See Appendix A.2.2.

Proposition 2 establishes that concentration of firms is embedded in the industrial equilibrium because it captures the aggregate markup response to changes in competition. To fix ideas, we can further relate this measure to the HHI by doing a first order approximation around $\sigma = 2$:²⁷

$$\Psi_r^l \approx (\sigma - 1)s_r h_r^l HHI_r^l - (\sigma - 2)(s_r h_r^l)^2 HHI_r^l(3) \quad (20)$$

where $HHI(3) = \sum_{i=1}^N z_i^3$. When $\sigma = 2$, $\Psi_r^l = s_r h_r^l HHI_r^l$ and therefore $\frac{\partial \log P_r^l}{\partial \log P}$ is proportional to HHI_r^l .²⁸ In this sense, concentration is microfounded by the model.

2.2.2 Industry Price Index

In this section I examine how tariffs affect the CES industry price index in the hybrid model. To do so, let's first define the small firms' analogous expression to Ψ_r^l :

$$\Lambda_r^s \equiv -\frac{\partial \log P_r^s}{\partial \log P} = \frac{k - (\sigma - 1)}{\sigma - 1} \frac{(c_{r,*}^s)^{k-(\sigma-1)}}{(c_{r,*}^s)^{k-(\sigma-1)} - (c_L^s)^{k-(\sigma-1)}} \quad (21)$$

In contrast to large firms, small firms do not respond individually to changes in competition since their markups are fixed. Nonetheless, when P increases, more firms enter decreasing P_r^s . Therefore, the price index of small and large firms react in opposite directions to changes in competition. The function Λ_r^s is

²⁷Derivation in Appendix A.1.2.

²⁸It is exactly HHI_r^l in the case of a closed economy with only oligopolistic firms.

proportional to the hazard function λ_r^s of the bounded Pareto distribution of export sales, as shown by Melitz and Redding (2015).²⁹

In the following proposition I identify the new channel introduced by large firms through which trade liberalization can affect competition and thus consumers in the context of the standard model.

Proposition 3. Industry Price Index Elasticity. (a) *The elasticity of the price index with respect to tariffs can be decomposed into (i) a price term (22), (ii) a relative large firms concentration term (23), (iii) a relative small firms entry term (24), and (iv) a cross-size term (25):*

$$\frac{d \log P}{d \log \tau} = s_f \quad (22)$$

$$+ \frac{(h^l)^2}{H} s_f^l (1 - s_f^l) (\Psi_d^l - \Psi_f^l) \quad (23)$$

$$+ \frac{(1 - h^l)^2}{H} s_f^s (1 - s_f^s) (\Lambda_f^s - \Lambda_d^s) \quad (24)$$

$$+ \frac{(1 - h^l) h^l}{H} \left[s_f^s (1 - s_f^l) [\Psi_d^l + b \Lambda_f^s] - (1 - s_f^s) s_f^l [\Psi_f^l + \Lambda_d^s] \right] \quad (25)$$

where $H \equiv 1 - h^l \Psi^l + (1 - h^l) \frac{\Lambda^s}{\sigma - 1} > 0$ is the overall equilibrium response and $b > 1$ is a factor correcting by the difference between $\frac{\partial \log P_r^s}{\partial \log P}$ and $\frac{\partial \log P_r^s}{\partial \log \tau}$.³⁰

(b) *The elasticity of the price index with respect to tariffs takes values between 0 and $\frac{\sigma}{\sigma - 1}$.*

Proof: See Appendix A.2.3

There are two special cases that are worth highlighting in part (a). The first one is when there are only small firms ($N_f^l = N_d^l = 0$). In that case, this expression only retains the price effect and the term 24, which captures the gains from trade due to product variety. In a symmetric setting, this term is positive as long as there are more small domestic firms than small foreign firms in the industry, all else equal. In the special case where the Pareto distribution is unbounded ($c_L^s = 0$), this term vanishes showing that there are no gains from trade due to product variety in the standard monopolistic model, as argued by Feenstra (2018).

The second special case is when there are no small firms ($c_L^s = c_H^s$). In this case, the gains from trade only come from the pro-competitive term, 23, which captures whether markups will decrease or increase depending on the relative concentration between domestic and foreign large firms. Note that its sign is not determined and depends on the specific productivity draws of granular firms. Given that this mechanism is especially important when the market is evenly distributed (i.e. $s_f^l = 1/2$), opening to trade when foreign firms are relatively more concentrated implies that pro-competitive effects can be negative.

In the case where there are both large and small firms, each of the previous terms is qualified by how much more productive large firms are. This is captured by h_l : the more productive large firms are relative

²⁹The hazard function is exactly $\lambda_r^s = (\sigma - 1) \Lambda_r^s$.

³⁰ $b \equiv \frac{1 - s_f^l + \frac{1}{h^l(\sigma - 1)}}{1 - s_f^l}$. In the case of $\frac{d \log P}{d \log T_f}$, $b = 1$ because $\frac{\partial \log P_r^s}{\partial \log P} = \frac{\partial \log P_r^s}{\partial \log T_f}$. Details in the proof.

to small firms, the higher will be their market share, even after taking into account their higher markups. In addition, the terms 23 and 24 are not enough to capture the pro-competitive and product variety gains from trade since there are cross-effects between the two types of firms, as captured by term 25. For example, a decrease in tariffs will increase foreign entry by more when Λ_f^s is high, and therefore will amplify the tariff effect by further decreasing domestic markups.

In part (b) of Proposition 3 I establish that the price index elasticity is always positive and bounded above. To see this, we can write the price index as follows:

$$\frac{d \log P}{d \log \tau} = s_f \frac{\tilde{H}_f}{H} \quad (26)$$

where $\tilde{H}_f \equiv 1 - h_f^l \Psi_f^l + (1 - h_f^l) \Lambda_f^s \frac{\sigma}{\sigma-1} > 0$.³¹ Given that $\frac{\tilde{H}_f}{H} > 0$, the elasticity is always positive and depends on the ratio of foreign to overall equilibrium responses.

2.2.3 Domestic Concentration

Given the evidence of an increase in domestic concentration in developed economies, it is useful to study the predictions of this model in a setting where foreign competition increases. In light of the model, such increase can be caused by any factor decreasing the relative price of imports such as tariffs or an increase in foreign firms' productivities.

I analyze the relationship between competition and domestic concentration by means of the Herfindahl-Hirschman Index (HHI). In this regard, Proposition 4 decomposes and signs the elasticity of HHI with respect to the CES industry price index:

Proposition 4. *Domestic Concentration and Competition.* (a) *The elasticity of domestic concentration as captured by the HHI with respect to the CES industry price index depends on (i) within large firms market shares reallocation (27), (ii) within small firms market share reallocation (28), and (iii) cross-size market share reallocation (29):*

$$\frac{d \log HHI_d}{d \log P} = -2(\sigma - 1) \sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i}^l \right] \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} \quad (27)$$

$$+ \left[\lambda_{2,d}^s - 2\lambda_d^s \right] \quad (28)$$

$$+ 2(1 - 2h_d^l)(\sigma - 1) [\Lambda_d^s + \Psi_d^l] \quad (29)$$

where $\lambda_{2,d}^s \equiv [k - 2(\sigma - 1)] \frac{c_{d,*}^{k-2(\sigma-1)}}{c_{d,*}^{k-2(\sigma-1)} - c_L^{k-2(\sigma-1)}}$ is the hazard function of a bounded Pareto distribution with shape parameter $k - 2(\sigma - 1) > 0$, and $\gamma_{d,i}^l \equiv \frac{(z_{d,i}^l)^2}{\sum_{i=1}^{N_d^l} (z_{d,i}^l)^2}$ are HHI -specific weights.

³¹Note that $\Psi_f^l \in (0, 1)$ and therefore $1 - h_f^l \Psi_f^l > 0$.

(b) Any shock that increases competition increases domestic concentration when the market share of large domestic firms is no smaller than the market share of small domestic firms ($h_d^l \geq \frac{1}{2}$).

Proof: See Appendix A.2.4.

We can analyze two special cases: only small and only large firms. In the first case, the resulting expression is term 28 which only depends on the relationship between two Pareto distribution with different shape parameters. The term λ_d^s is the usual hazard function of the distribution of sales with bounded Pareto, which has shape parameter $k - (\sigma - 1)$ and location $c_{d,*}^s$ under the usual condition that $k > \sigma - 1$; whereas the term $\lambda_{2,d}^s$ is the hazard function of a Pareto distribution that weights individual sales differently depending on the concentration measure. In the case of the HHI , the shape parameter of such Pareto distribution is $k - 2(\sigma - 1)$.³² The sign of this term is always negative when using a Pareto distribution, and we can gain intuition by analyzing the special case of an unbounded distribution:

$$\frac{d \log HHI_d}{d \log P} = -\frac{k}{\sigma - 1} \quad (30)$$

This expression captures the impact on the distribution of market shares that happens only through firm turnover. Therefore, any shock that increases competition decreases P , which causes exit and an increase of surviving firms' market shares proportional to their productivity. In terms of the magnitude of this elasticity, the higher is k , the higher will be the response of entry to competition because firms are more homogeneous. Therefore, a decrease in P will reallocate more market share towards surviving firms. When σ is high, entry is less responsive because residual demand for potential entrants is lower. Therefore, HHI_d is less responsive to P .

In the case with only large firms, the impact of P on HHI_d depends on the reallocation of market shares due to changes in markups. This is captured by the discrete weights that each function, P and HHI , assigns to each firm response, $z_{d,i}^l$ and $\gamma_{d,i}^l$ respectively. Its sign is always well-defined because HHI is an increasing convex function in the unit interval, which implies assigning higher weights to relatively larger firms. This means that the difference in weights, $\gamma_{d,i}^l - z_{d,i}^l$, is higher for the higher markup equilibrium responses. As a result, the impact of P on HHI_d is negative.

When there are both large and small firms, a change in P will also reallocate market shares across firm sizes as captured by term 29. Its sign is negative when large firms have a higher market share than small firms. The intuition is that any shock that increases competition decreases the price index of large domestic firms and increases the price index of small domestic firm, reducing the relative price of varieties produced by large firms. Hence, if $h_d^l > 1 - h_d^l$ then the set of firms that gains market share is the one that already had most of the market. Thus, concentration increases.

³²Using this concentration measure is only valid for industries with $k > 2(\sigma - 1)$ given that the shape parameter of a Pareto distribution is restricted to be positive.

3 An Application to Discriminatory Trade Policy

In this section, I apply the model to changes in trade policy in Colombia over the 2010-2013 period which led to the differential treatment of a subset of WTO members. In order to do so, I generalize the standard gravity equation to hybrid competition in a multi-country setting.

3.1 An Oligopoly-Augmented Gravity Equation

Let's assume there are many exporters and importers, indexed by c and d respectively. In the standard international trade model of heterogeneous firms with monopolistic competition, the relation between the change in trade flows, trade costs and multilateral resistance terms takes the following form:³³

$$d \log M_{cd}^{MC} = -\theta^{MC} d \log T_{cd} + \delta_c^G + \delta_d^G \quad (31)$$

where M_{cd} are d imports from c , T_{cd} are ad-valorem trade costs, θ^{MC} is the trade elasticity and δ_c^G and δ_d^G are destination and origin multilateral resistance terms that capture c supply capabilities and d market potential.

The trade elasticity θ^{MC} captures both the extensive and intensive margin effects of changes in trade costs. As shown by Chaney (2008), if we assume homogeneous firms acting under monopolistic competition, the trade elasticity is simply $\sigma - 1$ as in Krugman (1980). However, If there are heterogeneous firms whose productivity distribution follows an unbounded Pareto with shape parameter k , there is also an extensive margin elasticity that is equal to $k - (\sigma - 1)$. This means that the trade elasticity is k (the sum of the intensive and the extensive margin elasticities). Given the regularity condition $k > (\sigma - 1)$, the elasticity under firm heterogeneity is higher, reflecting the fact that decreasing trade costs not only decrease the price of existing varieties but also induce entry of new varieties.

A key assumption of these models is that firms do not act strategically when setting prices or quantities. Given that the industry model I consider includes firms that do act strategically, we also need to account for changes in c 's market power at d . Not accounting for it in the presence of oligopolistic behavior will lead to a misspecification of the gravity equation in changes. The hybrid model provides an interpretation of the structural change in the trade elasticity that occurs when we do not include such change in market power. This is summarized in the following proposition.

Proposition 5. *Oligopoly-Augmented Gravity Equation and Partial Trade Elasticity.* *In the hybrid model with oligopolistic competition the gravity equation in changes is:*

$$d \log M_{cd}^{HC} = -\theta_{cd}^{HC} d \log T_{cd} + \delta_{cd}^H, \quad (32)$$

³³In order to directly compare to Chaney (2008), in this section I consider trade costs faced by producers. Differently, tariffs are defined as the difference between the consumer and the producer price. Conclusions do not differ when using tariffs and the only difference is a fixed factor modifying the standard trade elasticity as shown below.

where the partial trade elasticity is:

$$\theta_{cd}^{HC} = (\sigma - 1)[1 + (1 - h_{cd}^l)\Lambda_{cd}^s - h_{cd}^l\Psi_{cd}^l], \quad (33)$$

and δ_{cd}^H captures the change in multilateral resistance terms.³⁴

Proof: See Appendix A.2.5.

This expression shows that by including granular firms, the impact of trade costs has an extra margin, $h_{cd}^l\Psi_{cd}^l$, relative to a setting with monopolistic competition. In addition, note that θ_{cd}^{HC} is equal to k when there are no large firms, and the productivity distribution is unbounded as in Chaney (2008).³⁵ Moreover, $(\sigma - 1)\Lambda_{cd}^s$ is the hazard function identified by Melitz and Redding (2015) and it is related to the marginal gain of adding an extra small firm. When there are few small foreign firms selling in the market, the trade elasticity increases because the marginal welfare gain is high.³⁶

The novel object included in the trade elasticity is the last term, which I call the *oligopolistic margin*. This margin depends on two variables: the share of large foreign firms in d imports from c , h_{cd}^l , and the concentration measure, Ψ_{cd}^l . Given that $h_{cd}^l\Psi_{cd}^l$ is lower than one, the inclusion of oligopolistic firms makes trade flows less elastic to changes in trade costs but does not reverse the sign of their effect. The intuition is simple: large firms absorb changes in trade costs by modifying markups. The more important in terms of overall market shares and the more concentrated they are, the more they are able to do so.³⁷

3.2 Empirical Setting

3.2.1 Institutional Setting

I exploit a country-level change in the preferential treatment of exporters to Colombia from two types of events. First, Colombia implemented a unilateral trade liberalization (UTL) in 2010-2011 to all members of the WTO. The Colombian government argued that the country had a large inefficient dispersion in tariffs (cf. Torres and Romero, 2013). Next, Colombia signed significant Free Trade Agreements (FTAs) with Canada (2011), the US (2012), and the European Union (2013).

The UTL was a reform that covered most of the product spectrum. Exporting countries that were

³⁴In this model, the multilateral resistance terms need to account for the imperfect pass-through due to markups and bounded Pareto: $\delta_{cd}^H \equiv (1 - h_{cd}^l)d \log N_{cd} + [1 + (1 - h_{cd}^l)\Lambda_{cd}^s]d \log E_p + (\sigma - 1)[1 + (1 - h_{cd}^l)\Lambda_{cd}^s - h_{cd}^l\Psi_{cd}^l]d \log P$.

³⁵The elasticity of imports with respect to tariffs is slightly different, given that tariffs are not paid by producers:

$$\theta_{cd}^{HC,\tau} = (\sigma - 1) + (1 - h_{cd}^l)\frac{\sigma}{\sigma - 1}\Lambda_{cd}^s - h_{cd}^l\Psi_{cd}^l$$

³⁶Even though the marginal gain of new varieties decreases as more firms enter, it is always positive. In Feenstra and Weinstein (2017), the translog preferences add an extra term with a negative effect that they interpreted as crowding of the variety space.

³⁷Fernandes et al. (2019) show that the intensive margin elasticity is increasing in firm size, which may seem to contradict that larger firms react less to changes in trade policy given that they modify their markups. However, their definition of the intensive margin elasticity refers to how much of bilateral trade can be explained by exports per firm at different percentiles. In this sense, my model assumes that the number of large firms and the share they explain can freely vary across bilateral flows, and therefore cannot be related to their setting.

benefited from this reduction were those receiving Most Favored Nation (MFN) status.³⁸ This reform was effective in decreasing average tariffs in approximately 5.8% from 2010 to 2017.

Before 2010, Colombia only had agreements granting preferential access to most Latin American and Caribbean (LAC) countries, but none to countries from the rest of world.³⁹ Therefore, any firm from countries outside LAC faced MFN tariffs to sell in Colombia.⁴⁰ This changed at the beginning of the 2010 decade since Colombia signed FTAs with countries outside LAC that had a significant share of Colombian imports. In 2011, the Canada FTA entered into force, an agreement that represented 1% of total imports.⁴¹ In 2012, the agreement with the US was put into force when the US Congress approved the bill after more than five years of negotiation. Imports from the US were 27% in 2010. Finally, the agreement with EU entered into force in 2013 and it represented 14% of Colombian imports in 2010. In sum, Colombia put into force FTAs with countries that represented 42% of its total imports. All these countries had MFN status before these agreements and would have faced the post-UTL tariffs were not they had the FTA. In comparison, non-LAC countries that were included in the UTL and did not end up having an agreement with Colombia represented 23% of total imports.

3.2.2 Identification

Estimating Sample. In order to conduct the analysis, I employ the subset of exporters that benefited from the UTL or signed an FTA with Colombia. Therefore I have two types of exporters that initially faced the same MFN tariff: those that ended up having FTAs and those that did not. For the reasons mentioned above, I do not include in the sample LAC countries, and neither do I include countries that got preferential status after 2013 to avoid heterogeneity in terms of the timing of the application.⁴²

Empirical Equation. I employ the gravity equation presented in the previous section to estimate whether exporter-products with a relatively high concentration measure Ψ have a lower elasticity. To do so, I expand equation 32 and interpret it as a first-order approximation around an initial equilibrium.⁴³

³⁸Latin American and Caribbean countries (LAC) were not reached by this reform given that most of them have multiple preferential schemes in place. I exclude all LAC countries from the analysis.

³⁹These regional agreements are the Andean Community with Peru, Ecuador and Bolivia (founded in 1969), the ALADI with all South American countries and Mexico (1980), and with CARICOM (1994). In 2009 Colombia signed a Free Trade Agreement with Chile and the Northern Triangle (Guatemala, Honduras and El Salvador).

⁴⁰Colombian firms did have preferential access to developed countries such as the US and EU in subsets of products as part of the non-reciprocal tariffs schemes these countries offer to developing countries.

⁴¹In 2011 the agreement with EFTA countries entered into forced too. However, it was immediately effective only for Switzerland and Liechtenstein. It was effective for Iceland and Norway in 2015.

⁴²These are with EFTA (fully in force in 2015) and Korea (2016).

⁴³I also include tariffs which were excluded for exposition in the previous section. Details of the derivation in Appendix A.2.5.

$$\begin{aligned}
\Delta \log M_{cp} &= [1 + (1 - h_{cp,t-1}^l) \Lambda_{cp,t-1}^s] \Delta \log E_p - \\
&- (\sigma - 1) [1 + (1 - h_{cp,t-1}^l) \frac{\sigma}{\sigma - 1} \Lambda_{cp,t-1}^s - h_{cp,t-1}^l \Psi_{cp,t-1}] \Delta \log \tau_{cp} + \\
&+ (\sigma - 1) [1 + (1 - h_{cp,t-1}^l) \Lambda_{cp,t-1}^s - h_{cp,t-1}^l \Psi_{cp,t-1}] \left[\Delta \log P_p - \right. \\
&- \left. \Delta \log T_{cp} - \Delta \log w_c \right] + (1 - h_{cp,t-1}^l) \Delta \log N_{cp}^s + v_{ip}
\end{aligned} \tag{34}$$

where p indexes a products (HS at 6 digits level), T_{cp} is the ad-valorem exporter-product specific transport costs, τ_{cp} is the ad-valorem effectively applied tariff, E_p is expenditure on p , w_c are production costs in c , N_{cp}^s is the measure of potential small entrants, and v_{cp} is a mean zero approximation error.⁴⁴ Differences are taken with respect to $t - 1$ which means that the initial market structure will determine how each flow reacts.

Identifying Assumptions. Including the exporter and product fixed effects implies that I use diff-in-diff variation to identify the effect. In this section I formally outline the identifying assumptions:

A1. Constant deep parameters σ and k across exporters, products and time; stationary $\Lambda_{cp}^s = \Lambda^s$ and

$$h_{cp}^l = h^l.$$

A2. Exogenous exporter-specific production costs w_c relative to tariffs.

A3. Elasticity of substitution across products equal to one.

A4. Potential entrants are determined by a product-specific, exporter-specific and an idiosyncratic factor:

$$\log N_{cp}^s = \log N_p^s + \log N_c^s + \log \zeta_{cp}^s, \text{ with } E(\log \zeta^s) = 0.$$

Assumption A1 implies that variation across products does not come from different parameters but rather from different initial market structures and tariffs. This is a standard assumption in the literature. The stationary feature of Λ^s implies that the entry cutoff is sufficiently far from the upper productivity bound. In fact, being sufficiently far from that parameter implies that Λ tends to $\frac{k}{\sigma-1} - 1$. Assuming an homogeneous h_l implies that actual variation in this variable will be captured by concentration. I show that this variable is equal or very close to one in most cases and test this restriction in the regression section.

Assumption A2 is done to focus on industry variables and avoid general equilibrium effects. Given the product level of aggregation I am employing, this assumption is reasonable (the HS at 6-digits includes approximately 5000 categories). Moreover, I am not including countries that are in the same region for which Colombia is potentially an important export destination.

Assumption A3 holds if the HS6 classification is identifying products that are not sufficiently close in the product spectrum. The functional form of the oligopolistic margin and therefore the augmented gravity

⁴⁴Note that I used the term T_f to account for both T_{cp} and w_c in the theory section.

equation depends on this assumption. However, this assumption is more likely to not hold when a single firm is close to being a monopolist within a product across all exporters. In that case, the competition the firm cares about is the one between products rather than within the same product.

In order to derive the empirical equation under the previous assumptions, note that the concentration measure affects all variables determining prices, including the price index P . This means that simply including fixed effects to control for changes in P and production costs will not be enough to account for the entire impact of the oligopolistic behavior. Therefore, we also need to allow for product and exporter-specific slopes relative to Ψ . Note that estimating the standard gravity equation in the presence of strategic behavior implies that the equation is misspecified because the original gravity equation omits the interaction between tariffs and initial market power. As a result, standard trade elasticity estimates are biased if there are oligopolistic firms.

Under the assumptions A1-A4, we get:

$$\begin{aligned}
\Delta \log M_{cp} &= \alpha_{\tau}^{MC} \Delta \log \tau_{cp} + \alpha^{OC} \Psi_{cp,t-1} \Delta \log \tau_{cp} + \\
&+ \alpha_T^{MC} \Delta \log T_{cp} + \alpha^{OC} \Psi_{cp,t-1} \Delta \log T_{cp} + \\
&+ [\delta_p^I + \delta_p^S \Psi_{cp,t-1}] \\
&+ [\delta_c^I + \delta_c^S \Psi_{cp,t-1}] \\
&+ u_{cp}
\end{aligned} \tag{35}$$

where:

$$\alpha_{\tau}^{MC} = (1 - \sigma) [1 + (1 - h^l) \frac{\sigma}{\sigma - 1} \Lambda^s] < 0$$

$$\alpha_T^{MC} = (1 - \sigma) [1 + (1 - h^l) \Lambda^s] < 0$$

$$\alpha^{OC} = -h^l (1 - \sigma) > 0$$

$$\delta_p^I = (\sigma - 1) [1 + (1 - h^l) \Lambda^s \Delta \log P_p + [1 + (1 - h^l) \Lambda^s] \Delta \log E_p + (1 - h^l) \Delta \log N_p]$$

$$\delta_p^S = (\sigma - 1) h^l \Delta \log P_p$$

$$\delta_c^I = (1 - \sigma) [1 + (1 - h^l) \Lambda^s] \Delta \log w_c + (1 - h^l) \Delta \log N_c$$

$$\delta_c^S = -h^l (1 - \sigma) \Delta \log w_c$$

$$u_{cp} = (1 - h^l) \Delta \log \zeta_{cp}^s + v_{cp}$$

where note that $E(u_{cp}) = 0$.⁴⁵

⁴⁵Some papers suggest that the level of concentration can influence the change in tariffs over a period of trade liberalization (e.g. Ferreira and Facchini, 2005). Note that if this is the case, the specification in equation 35 controls for that possibility as long as the initial level of concentration captures the relevant information for future changes in tariffs.

3.2.3 Data and Descriptive Section

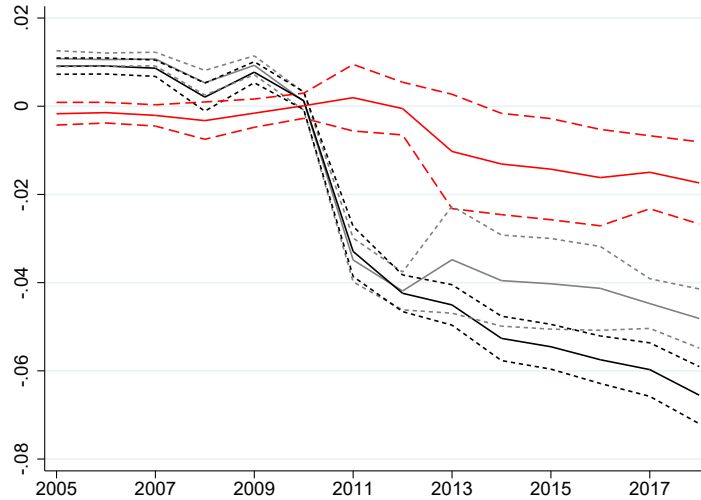
In this section I describe the data I employ for the empirical analysis and provide descriptive statistics.

Data. The main source of information is customs data from DANE (National Administrative Department of Statistics by its Spanish acronym) that covers imports from 2004 to 2018. This information is detailed since it includes all transactions recorded in administrative custom data between Colombian and foreign firms. The most relevant information it includes for this analysis are total imports in CIF and FOB terms, quantity, weight, HS 10-digit product classification (HS10), the exporting country, the city and country of the seller, and the effectively applied tariff. This detailed data helps me to construct import data aggregated to HS6-exporter-year to line it up with the theoretical predictions.

I also use the Export Dynamic Database (EDD) from the World Bank to compare its information with trade flows and concentration measures calculated using the DANE database as detailed in a subsequent section. Finally, I use the Annual Manufacturing Survey (EAM) from DANE to do robustness checks that include domestic Colombian firms.

UTL and FTA Applied Tariffs. We can observe the UTL and FTA change in trade policy by using the effectively applied tariff included in the DANE import data. Under the UTL, all countries faced the same decrease in tariffs for each product. In addition, those with an FTA with Colombia had an extra decrease that was negotiated in each specific agreement.

Figure 1: Average log Change in Tariffs Faced by UTL and FTA Exporters and Relative Change between UTL and FTA Exporters.



Black: FTA, Gray: UTL, Red: Difference

Note: Data from DANE custom data as detailed in the data section. FTA and UTL lines are the year-specific coefficients from the regression $\log \tau_{cpt}^r = \sum_{r \in UTL, FTA} \sum_{t=2007}^{2016} \beta_t^r + \delta_{cp} + \epsilon_{cpt}$ where $\log \tau_{cpt}^r$ is the effectively ad-valorem tariff paid by exporter c in 6-digits HS product p , where r could be the UTL and FTA regime, and δ_{cp} is a exporter-HS6 product level fixed effect. The difference line are the year-specific coefficients from the regression $\log \tau_{cpt}^r = \sum_{t=2007}^{2016} \beta_t + \sum_{t=2007}^{2016} \beta_t^{FTA} 1\{c \in FTA\} + \delta_{cp} + \epsilon_{cpt}$. Both regressions weighted by imports at the cpt level. Robust standard errors.

In Figure 1 we can observe that both UTL and FTA countries faced a significant decrease in average tariffs, which difference was significant after 2014.

In order to establish a benchmark for the analysis, I employ the 2007-2017 time period. First, I use 2007 to avoid using the 2008-2010 period in which global trade collapsed due to the Great Recession. Moreover, FTA negotiations usually take years. Therefore, using a year that is not close to the entry into force of such agreements implies that firms probably did not anticipate the future agreement. Second, I use 2017 because it is at a reasonable distance from the last considered agreement that entered into force (EU in 2013). Given that tariffs progressively decline under FTAs, using the first year (i.e. 2014) after the agreements may not provide the additional variation required for the analysis. This can be seen in Figure 1 as tariffs continued declining for FTA countries. I use alternative time periods for robustness checks.

Firm Proxy. The import database provided by DANE does not include an identifier nor a name for the foreign firm exporting to Colombia. Given that I need firm level data to link the empirical concentration measure to the theory, I construct a proxy for firms by using the available information in the DANE database. I argue that the city and country of the seller and the HS10 product level can be exploited with that goal. The location of the seller can differ from the country in which production takes place. I assume that the seller establishes the optimal production and the producer follows that decision and ships the good. Therefore, gravity forces act as usual and I can use the extra information from the firm location to proxy for firms (i.e. trade costs are determined by the exporting and importing country since the goods have to physically be moved between these two countries, and production costs are determined by the supplier access of such exporter).⁴⁶

In order to validate this proxy, I use the EDD which includes the number of firms and concentration measures such as the *HHI* for all exporter-years included in the sample. When comparing the average concentration calculated by using the exporter proxy in the DANE data both are similar, although lower in the case of DANE (0.313 vs. 0.380 in EDD). Despite that, correlation between the two across exporter-HS2-years is high (0.794), especially when having as benchmark the correlation of DANE and EDD trade flows (0.855).⁴⁷

Descriptive Statistics. In order to contextualize the regression results, I summarize the main variables in Table 1.

⁴⁶The seller and the shipper is frequently in the same city in the data.

⁴⁷The concentration proxy explains 68% of the variation in EDD's *HHI*, which is also high when compared to the 73% that the DANE trade data explains of EDD exports. In this last calculation no proxy is needed and therefore I use it as benchmark for the comparison. There are two potential sources of this discrepancy: (i) EDD is export data and DANE is import data, (ii) the World Bank may be homogenizing results across different exporters differently, for instance in terms of product classifications.

Table 1: Descriptive Statistics. Baseline Sample (2007-2017).

	All		FTA		UTL	
	Average	s.d.	Average	s.d.	Average	s.d.
$\Delta \log M$	0.357	2.421	0.209	2.347	0.607	2.522
$\Delta \log \tau$	-0.066	0.045	-0.071	0.046	-0.058	0.041
$\Delta \log T$	-0.028	0.123	-0.023	0.122	-0.037	0.125
Share of Top 4 Firms at $t - 1$	0.930	0.134	0.935	0.128	0.922	0.145
Ψ_{t-1} (Top 4 Firms)	0.086	0.151	0.088	0.156	0.083	0.144
HHI_{t-1} (Top 4 Firms)	0.642	0.273	0.645	0.270	0.637	0.277
HHI_{t-1}	0.604	0.314	0.608	0.309	0.596	0.321
N	26,142		16,422		9,720	

Note: Variables in changes calculated for the 2007-2017 period. Variables evaluated at $t - 1$ correspond to 2007. Top and bottom 0.01% of variables in changes not considered.

The first salient result is that imports from UTL countries increased significantly more. In fact, the average growth rate is almost three times bigger for these countries. It is worth noting that China is included in this sample and imports from this country increased more than three times over the 2007-2017 period. However, not including China does not change the fact that UTL countries grew more. One potential factor explaining it may be the higher decrease in transport costs measured by the difference between CIF and FOB import valuation. In the table this is shown by $\Delta \log T$, where T is calculated as an ad-valorem trade cost. I use this measure in the regression analysis as a control.

In terms of the relative market power, the unobserved behavior of firms implies that I have to assume which firms behave as large and which as small. In that regard, I define as granular firms the top four within an exporter-product.⁴⁸ Therefore, I construct the Ψ for the top four firms and assume that $\sigma = 4$, a value that is centered within the range of what other papers have estimated.

Using the Ψ constructed as explained, we can see that FTA countries had a lower pass-through overall, with an absorption of 0.088 versus 0.083 for UTL countries. This could also have helped UTL countries to increase their relative exports to Colombia.

Note that the HHI and the share of top four firms give mixed evidence on which set of countries was initially more concentrated. In addition, note that the average share of top firms is 0.95, which shows the high granularity of the data at the exporter-product level. In fact, if we assume that this variable is a proxy for the share of granular firms, h_{cp}^l , we would conclude that about 40% of the exporter-products have four or less firms selling to Colombia and about 75% of them would have more than 90% of sales concentrated in the top four firms.

⁴⁸The share of top four firms is another widely used measure of concentration. For instance, Autor et al. (2017) use both the share of top four and twenty firms to characterize the increase in US concentration.

3.3 Empirical Results

3.3.1 Baseline Results

The theory predicts that changes in tariffs will be partially absorbed by the industry structure of the affected exporter. Without assuming oligopolistic behavior, we would estimate the effect of tariffs without considering the initial concentration. In column 1 of Table 2 I estimate this equation. The elasticity of imports with respect to tariffs is negative and significant as predicted by the theory and its magnitude is in line with the literature.

Table 2: Baseline Results. Monopolistic Competition and Hybrid Competition.

	MC model	Hybrid Model	Hybrid Model
	(1)	(2)	(3)
$\Delta \log \tau_{cp}$	-5.294*** (0.815)	-4.690*** (0.959)	-4.064*** (0.902)
$\Delta \log \tau_{cp} \times \Psi_{cp,t-1}$			2.254** (1.119)
$\Delta \log T_{cp}$	-2.788*** (0.222)	-2.394*** (0.232)	-2.474*** (0.261)
$\Delta \log T_{cp} \times \Psi_{cp,t-1}$			-0.206 (0.336)
Exporter Fixed Effect	Yes	Yes	Yes
HS6 Fixed Effect	Yes	Yes	Yes
Exporter-specific Ψ Slopes	No	Yes	Yes
HS6-specific Ψ Slopes	No	Yes	Yes
Observations	26,142	26,142	26,142
R-squared	0.272	0.427	0.428
Adjusted R-squared	0.166	0.230	0.231
Restriction p-value $h^l = 1$ ($(\sigma - 1)h^l = 3$)	-	-	0.109
Restriction p-value $h^l = 0.9$ ($(\sigma - 1)h^l = 2.7$)	-	-	0.10

Note: OLS Regressions. Variables in changes calculated for the 2007-2017 period. Variables evaluated at $t - 1$ correspond to 2007. Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . MC model: Exporter and HS6 fixed effects. Hybrid model: MC model fixed effects plus exporter and HS6-specific slopes relative to Ψ . Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

However, the granular feature of exporters suggests that firms may have exploited their size to rise

markups. In column 2, I interact the product and exporter fixed effects by industrial concentration as defined by the model in order to have a benchmark for the baseline result. In this case, the tariff elasticity is influenced by the underlying distribution of Ψ . Note that both the R^2 and adjusted R^2 increase by about 50%, showing that the hybrid model has substantially higher explanatory power.

Column 3 presents the baseline results where I also interact tariffs and transport costs by a demeaned Ψ . The elasticity of imports with respect to tariffs at the mean Ψ is -4.064 , whereas an increase of one standard deviation of this variable decreases the elasticity by 55%. This shows that the oligopolistic margin has a strong influence on the trade elasticity.

In terms of the effect of transport costs on imports, the impact at the mean is significant and the elasticity is -2.474 . However, the interaction with the standardized Ψ is insignificant. Given that there can be other factors affecting this variable and it may be observed with measurement error, I will focus on analyzing the tariff elasticity henceforth.⁴⁹⁵⁰

Assumption A1 imposes h^l to be constant across countries. Three quarters of the flows have a share of top four firms that is higher than 90%. Therefore, I test whether this variable can be assumed to be constant using the baseline specification. Given that I assume that $\sigma = 4$ when constructing Ψ , I test the restriction $\alpha^{\hat{OC}} = 3 * h_l$. I cannot reject the null hypothesis of $h_l = 1$ and $h_l = 0.9$, which means that there is no evidence of a misspecified restriction.

3.3.2 Robustness

In order to construct Ψ I had to assume which firms I treat as large. Therefore, I use different definitions of Ψ to assure that there is nothing specific about the way I am construction the variable. In Table 3 I include all the different definitions of Ψ I employ.

⁴⁹A potential source of measurement error may be its aggregation. I aggregate this variable by taking the simple average across transactions within each exporter-product after eliminating outliers. Other ways of aggregating this variable yield similar results.

⁵⁰As long as tariffs are not correlated with export-product specific transport costs, the tariff coefficient is unbiased.

Table 3: Robustness: Concentration Measure Definition.

	Top firm	Top 20 firms	W/domestic firms	Overall share > 1%	Variable σ	Simple av- erage
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log \tau_{cp}$	-4.064*** (0.898)	-4.137*** (0.909)	-3.448*** (0.962)	-4.274*** (0.896)	-4.214*** (0.946)	-3.877*** (0.897)
$\Delta \log \tau_{cp} \times \Psi_{cp,t-1}$	2.294** (1.113)	1.929* (1.091)	3.135** (1.442)	1.766 (1.081)	2.374** (1.136)	3.012** (1.303)
$\Delta \log T_{cp}$	-2.489*** (0.261)	-2.450*** (0.258)	-2.409*** (0.270)	-2.459*** (0.256)	-2.300*** (0.249)	-2.466*** (0.264)
$\Delta \log T_{cp} \times \Psi_{cp,t-1}$	-0.226 (0.331)	-0.204 (0.337)	0.032 (0.352)	-0.147 (0.320)	0.281 (0.276)	-0.176 (0.361)
Observations	26,142	26,142	24,486	26,142	25,299	26,142
R-squared	0.425	0.433	0.414	0.423	0.422	0.418
Mean Ψ	0.101	0.0807	0.0501	0.0825	0.0708	0.0563
s.d. of Ψ	0.172	0.146	0.106	0.151	0.146	0.104

Note: OLS Regressions. Variables in changes calculated for the 2007-2017 period. Variables evaluated at $t - 1$ correspond to 2007. Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . Column 1: Ψ calculated using the top firm within the exporter-product. Column 2: Ψ calculated using the top 20 firms within the exporter-product. Column 3: Ψ calculated using the top 4 firms, including the imputed share of domestic firms. Column 4: Ψ calculated only for firms exceeding the > 1% in terms of overall market share (i.e. considering all origins). Column 5: Ψ constructed by using the HS6 level median σ from Broda and Weinstein (2006). Column 6: Constructing Ψ by simple averaging across firms rather than using the weighted average. Exporter and HS6 fixed effects and exporter and HS6-specific slopes relative to Ψ included. Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Columns 1 and 2 use the top firm and top twenty firms to calculate Ψ . As expected, none of them substantially change the baseline conclusions. When I use the top firm I get a similar coefficient to the baseline, showing that the largest firm provides useful variation to identify the oligopolistic margin. Using the top twenty firms marginally decreases the coefficient and makes it noisier. The decrease in its magnitude and precision may suggest that using the top twenty firms may classify small firms as large firms. In spite of this, it is statistically the same as the baseline coefficient.

To construct Ψ , I use the firm-specific market share across all exporters. However, foreign exporters also compete with domestic firms. In column 3, I use the market share of exporters taking into account also domestic sales imputed to those products.⁵¹ In this case, both $\alpha^{\hat{MC}}$ and $\alpha^{\hat{OC}}$ increase. As a result, the impact of an increase in a s.d. in Ψ is relatively high (90%).

Assuming that the top four firms behave oligopolistically across all exporters and products can also be a strong assumption. As a result, I alternatively define granular firms as those having more than 1% of total

⁵¹I employ the EAM to calculate domestic sales. However, the mismatch and different levels of classifications between domestic industry data and custom product level data implies that I may be introducing error into this measure.

Colombia imports in that product across all exporters. Column 4 shows that in this case, the oligopolistic margin has the right sign and similar magnitude to the baseline but is marginally insignificant.

Another assumption I make to construct Ψ is a fixed σ . As a robustness I use the Broda and Weinstein (2006) estimation of elasticities of substitutions for the US at the HS 10 digits level and take the median within each HS 6 digits level. Column 5 shows the results using this estimated parameters. Estimates are very similar to the baseline.

Another potential issue is capturing some sort of mechanical correlation when taking the weighted average of the markup equilibrium responses. I rule this out by taking the simple average. Column 6 shows that results are robust to this.

The assumption of having exporter-specific production costs may be strong if different industries use inputs with different intensities. Therefore, I relax this assumption by controlling for exporter-HS2 fixed effects. Columns 2 of Table 4 shows that the oligopolistic margin is robust to such control.

Table 4: Robustness: Alternative Specifications.

	(1)	(2)	(3)	(4)
$\Delta \log \tau_{cp}$	-4.064*** (0.902)	-4.197*** (1.101)	-5.569*** (0.974)	-6.136*** (1.012)
$\Delta \log \tau_{cp} \times \Psi_{cp,t-1}$	2.254** (1.119)	3.992** (1.662)		
$\Delta \log \tau_{cp} \times \text{High } \Psi_{cp,t-1} \text{ indicator}$			3.282* (1.734)	2.480 (1.687)
$\Delta \log T_{cp}$	-2.474*** (0.261)	-2.155*** (0.281)	-2.511*** (0.230)	-2.485*** (0.236)
$\Delta \log T_{cp} \times \Psi_{cp,t-1}$	-0.206 (0.336)	0.302 (0.471)		
$\Delta \log T_{cp} \times \text{High } \Psi_{cp,t-1} \text{ indicator}$			-0.179 (0.492)	0.164 (0.543)
Exporter fixed effects and Ψ slopes	Yes	No	No	No
Exporter-HS2 fixed effects and Ψ slopes	No	Yes	No	No
HS6 fixed effects and Ψ slopes	Yes	Yes	No	No
Exporter-Top Ψ indicator fixed effects	No	No	Yes	No
Exporter-HS2-Top Ψ indicator fixed effects	No	No	No	Yes
HS6-Top Ψ indicator fixed effects	No	No	Yes	Yes
Observations	26,142	25,596	24,703	23,640
R-squared	0.428	0.556	0.348	0.440

Note: OLS Regressions. Variables in changes calculated for the 2007-2017 period. Variables evaluated at $t - 1$ correspond to 2007.

Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . Exporter and HS6 fixed effects and exporter and HS6-specific slopes relative to Ψ included. High Ψ indicator captures the top quartile of the distribution of Ψ_{t-1} , where the 75th percentile is 0.095. Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Another potential issue may be the high number of interactions in which Ψ is involved given that it could be inflating the coefficient of interest due to potentially high collinearity. To rule out such scenario I construct an indicator that takes the value of one when the exporter-product flow is in the top quartile of the distribution of Ψ .⁵² I use this statistic and not the median given that the distribution of Ψ is positively

⁵²The 75th percentile of the Ψ distribution is 0.095.

skewed.⁵³

In columns 3 and 4 of Table 4 I interact the change in tariffs and all the fixed effects by the indicator to capture the two potentially different levels of the oligopolistic margin. In column 3 I use the baseline specification and find a positive and significant effect. In column 4 I also interact the baseline fixed effects by HS2 products. The result is marginally insignificant but it has the same sign and magnitude. This shows that the magnitude of the baseline estimations are not explained by potential collinearity.

Table 5: Robustness: Alternative Time Periods.

	2006-2016	2007-2017	2008-2018
	(1)	(2)	(3)
$\Delta \log \tau_{cp}$	-2.012*** (0.775)	-4.059*** (0.903)	-3.837*** (0.724)
$\Delta \log \tau_{cp} \times \Psi_{cp,t-1}$	2.570*** (0.909)	2.255** (1.120)	2.684** (1.198)
$\Delta \log T_{cp}$	-2.479*** (0.244)	-2.474*** (0.261)	-2.297*** (0.310)
$\Delta \log T_{cp} \times \Psi_{cp,t-1}$	-0.317 (0.403)	-0.206 (0.336)	-0.045 (0.383)
Observations	24,416	26,142	26,473
R-squared	0.448	0.428	0.427

Note: OLS Regressions. Variables in changes calculated for the period noted on the column header. Variables evaluated at $t - 1$ correspond to the base period of the change. Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . Exporter and HS6 fixed effects and exporter and HS6-specific slopes relative to Ψ included. Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Another potential issue may be the chosen baseline period. In Table 5 I show that I get similar estimates when I use the 2006-2016 and 2008-2018 time periods.

3.3.3 Endogenous Trends

Initial concentration as captured by Ψ may be correlated with import growth. For instance, young firms can find more ground for growth in foreign markets in relatively less concentrated and protected industries. As a result, the coefficients can be capturing a different relationship not necessarily related to the oligopolistic margin.

In this regard, finding a valid instrument would be the first best for addressing such endogeneity. However, the theoretical model implies that we need to account for all the different product and exporter-specific absorption caused by oligopolistic behavior. This means that in the case of finding an instrument for Ψ I need to instrument all the product and exporter-specific slopes as well. This is unfeasible given the number of interactions it implies.

I follow a different approach to deal with potential endogeneity. I assume that product and exporter-specific import growth is linear over the 2004-2017 period of time and stack two annualized differences, 2004-2007 and 2007-2017. Doing so allows me to control for exporter-product fixed effects.

⁵³The average Ψ for the three lower quartiles is 0.019 whereas in the case of the top quartile it is 0.29. Its skewness is 2.7.

Table 6: Deviations from Linear Trends. Monopolistic Competition and Hybrid Competition.

	MC model	Hybrid model	Hybrid model
	(1)	(2)	(3)
$\Delta \log \tau_{cpt}$	-6.058*** (0.966)	-4.719*** (1.069)	-2.199* (1.259)
$\Delta \log \tau_{cpt} \times \Psi_{cp,t-1}$			5.816*** (2.053)
$\Delta \log T_{cpt}$	-2.038*** (0.263)	-1.072*** (0.232)	-0.465 (0.359)
$\Delta \log T_{cpt} \times \Psi_{cp,t-1}$			1.219* (0.680)
Observations	39,436	39,436	39,436
R-squared	0.568	0.782	0.783

Note: OLS Regressions. Variables in changes stacked calculated and annualized for the 2007-2017 and 2004-2007 period. Variables evaluated at $t - 1$ correspond to 2004 and 2007. Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . MC model: Exporter-year, HS6-year and exporter-HS6 fixed effects. Hybrid model: MC model fixed effects plus exporter-year and HS6-year specific slopes relative to Ψ . Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In Table 6 I reproduce Table 2 with this specification. In column 1, I show that both the tariff and transport cost elasticity we would get in the standard specification are marginally higher although statistically the same as in Table 2. In column 3 I confirm that the oligopolistic margin is not explained by differential exporter-product linear trends. In addition, there is also evidence for the oligopolistic margin in the transport cost elasticity, which may suggest that controlling for these trends is especially relevant on a potentially endogenous variable.

3.3.4 Channels

The identified effect captures the total exporter-specific pass-through. However, I can decompose this variable to identify the different channels that play a role in the first order impact of tariffs on imports due to oligopolistic behavior. Note that the measure Ψ is a function of the large firms' market share, $s_{cp}^l = s_{cp} h_{cp}^l$, and the distribution of type (cp, l) shares, $\{z_{cp,i}^l\}$. Hence, we can decompose it as follows:

$$\Psi = \Psi_{\mathcal{M}} + \Psi_{\mathcal{C}} + \Psi_{\mathcal{N}} \quad (36)$$

where $\Psi_{\mathcal{M}} \equiv \Psi(s_{cp}^l, \{z_{cp,i}^l\}) - \Psi(1, \{z_{cp,i}^l\})$ accounts for the *market power shifter*, $\Psi_{\mathcal{C}} \equiv \Psi(1, \{z_{cp,i}^l\}) - \Psi(1, 1/N_{cp})$ accounts for the *conditional firm concentration*, and $\Psi_{\mathcal{N}} \equiv \Psi(1, 1/N_{cp})$ accounts for the *granular extensive margin*.

Table 7: Oligopolistic Channels.

	(1)
$\Delta \log \tau_{cp}$	-2.567** (1.116)
$\Delta \log \tau_{cp} \times \Psi_{\mathcal{M},cp,t-1}$	8.896*** (2.746)
$\Delta \log \tau_{cp} \times \Psi_{\mathcal{C},cp,t-1}$	3.846** (1.641)
$\Delta \log \tau_{cp} \times \Psi_{\mathcal{N},cp,t-1}$	8.533*** (2.763)
$\Delta \log T_{cp}$	-2.090*** (0.374)
$\Delta \log T_{cp} \times \Psi_{\mathcal{M},cp,t-1}$	-0.509 (0.915)
$\Delta \log T_{cp} \times \Psi_{\mathcal{C},cp,t-1}$	-0.147 (0.501)
$\Delta \log T_{cp} \times \Psi_{\mathcal{N},cp,t-1}$	-0.264 (0.859)
Observations	26,609
R-squared	0.612
$\Psi_{\mathcal{M}}$ average	-0.695
$\Psi_{\mathcal{M}}$ s.d.	0.233
$\Psi_{\mathcal{C}}$ average	0.115
$\Psi_{\mathcal{C}}$ s.d.	0.119
$\Psi_{\mathcal{N}}$ average	0.666
$\Psi_{\mathcal{N}}$ s.d.	0.204

Note: OLS Regressions. Variables in changes calculated for the 2007-2017 period. Variables evaluated at $t - 1$ correspond to 2007.

Top and bottom 0.01% of variables in changes not considered. Standardized Ψ . Exporter and HS6 fixed effects and exporter and HS6-specific slopes relative to all Ψ included. Standard errors clustered at HS2-type of Colombian policy treatment FTA-MFN status (354 clusters). Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In Table 7 I show the results when I interact the tariff and transport cost change with the variables capturing the different oligopolistic channels. The three channels are significant and imply a larger effect than in the baseline. A potential reason is multicollinearity given that the number of interactions significantly increased due to the interactions with the exporter and product fixed effects. However, the sign and magnitudes are stable across alternative specifications, which indicates that they may be capturing the

fundamental channels behind overall industrial concentration.

3.4 Quantitative Implications

In this section, I analyze the quantitative implications of the oligopolistic margin and their relationship with industrial concentration. First, I calculate the overall average and aggregate impact on imports of the trade liberalization process; and the differential average and aggregate impact on imports from FTA partners. Second, I show that employing the hybrid model is especially relevant in cases of high concentration. I conclude by arguing that concentration heterogeneity across countries within products justifies taking this margin into account when designing policy.

3.4.1 Average and Aggregate Effect

In this section I calculate the partial average and aggregate effect of changes in tariffs over the 2007-2017 period. In doing so, I separate the impact attributed to the extensive and intensive margin, and the impact attributed to the oligopolistic margin for both the overall impact and the FTAs differential impact.

The overall average effect is calculated as follows:

$$\overline{\Delta \log M^{HC,ave}} = \widehat{\alpha_{\tau}^{HC,I}} \overline{\Delta \log \tau} + \widehat{\alpha_{\tau}^{HC,S}} \overline{\Psi \Delta \log \tau} \quad (37)$$

where the first term captures the average intensive and extensive margin, and the second term the average oligopolistic margin. The differential impact due to FTA is calculated as follows:

$$\overline{\Delta \log M^{HC,ave_{diff}}} = \overline{\Delta \log M^{HC,ave_{FTA}}} - \overline{\Delta \log M^{HC,ave_{UTL}}} \quad (38)$$

where averages are taken over *FTA* and *UTL* countries depending the case.

In Table 8 I show that the oligopolistic margin reduces predicted overall import growth by about 8 log points, which is 24% less than what the intensive and extensive margins predict. In the case of the average *FTA* impact, the oligopolistic margin reduces by 2 log points the impact, yielding a relative increase in FTA imports of about 5 log points.

Table 8: Impact of Tariffs Reduction in the Hybrid Model (log points).

	Intensive and Extensive Margins	Oligopolistic Margin	Total Impact
<i>Overall</i>			
Average	35.5	-8.44	27.1
Aggregate	28.0	-18.1	9.91
<i>FTA vs. UTL</i>			
Average	7.04	-2.09	4.94
Aggregate	6.19	-5.69	0.501

Note: Calculations made by using baseline results in Table 2, Column 3 using non-standardized coefficients.

To calculate the overall aggregate effect, I use initial exporter-product import weights from 2007, $\rho_{cp} = \frac{M_{cp,2007}}{\sum_{cp=1}^n M_{cp,2007}}$, where n is the number of included observations:

$$\overline{\Delta \log M^{HC,agg}} = \widehat{\alpha_{\tau}^{HC,I}} \sum_{cp=1}^n \rho_{cp} \Delta \log \tau_{cp} + \widehat{\alpha_{\tau}^{HC,S}} \sum_{cp=1}^n \rho_{cp} \Psi_{cp} \Delta \log \tau_{cp} \quad (39)$$

where the first term captures the aggregate intensive and extensive margin, and the second term the aggregate oligopolistic margin.

The differential aggregate impact due to FTA is calculated as follows:

$$\overline{\Delta \log M^{HC,aggdiff}} = \overline{\Delta \log M^{HC,aggFTA}} - \overline{\Delta \log M^{HC,aggUTL}} \quad (40)$$

where weights are calculated within *FTA* and *UTL* countries, respectively.

As shown in Table 8, the aggregate total affect is a third part of the average effect. This difference is mostly explained by the importance of the oligopolistic margin, which reduces the predicted import growth by 18 log points in this case. The difference between the FTA and UTL aggregate impact is almost zero because the oligopolistic margin almost offsets the entire intensive and extensive margin impact.⁵⁴

3.4.2 Monopolistic Competitive Model vs. Hybrid Model

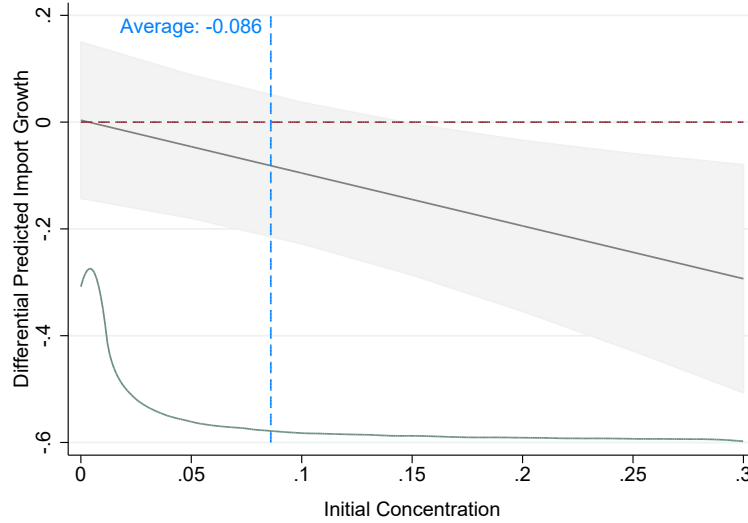
The trade elasticity is constant in the standard monopolistic competitive model where firms are sizeless and their distribution follows an unbounded Pareto. On the contrary, the trade elasticity can be potentially heterogeneous when there are granular firms and their country-specific distribution of market shares differ. To test if the hybrid model predictions differ from the standard model, I construct the following:

$$\Delta \log \widehat{M}^{HC} - \Delta \log \widehat{M}^{MC} = \left[\left[\widehat{\alpha_{\tau}^{HC,I}} - \widehat{\alpha_{\tau}^{MC}} \right] + \widehat{\alpha_{\tau}^{HC,S}} \Psi_{cp} \right] \overline{\Delta \log \tau} \quad (41)$$

⁵⁴These calculations do not account for the total effect because the estimated coefficients do not account for the overall impact. In that regard, the total impact may be different.

This equation delivers a distribution of predicted import growth that depends on the underlying distribution of industrial concentration. In Figure 2, I include both the distribution of Ψ and the differential predicted import growth at the average log tariff change (-0.066) for different values of Ψ . Specifically, I put the difference between predicted import growth in the hybrid model and predicted growth in the monopolistic model in the y-axis, and initial concentration as measured by Ψ in the x-axis.

Figure 2: Predicted Import Growth Differential Due to Granularity by Initial Concentration.



Note: Relationship between the differential predicted import growth due to changes in tariffs using baseline estimates from Table 2, Column 3 (monopolistically competitive model with no granular firms minus hybrid model with granular firms). Calculations at average $\Delta \log \tau = -0.066$. Confidence intervals at 90%. Kernel density of Ψ truncated at $\Psi < 0.3$ for clarity of exposition (the 91th percentile).

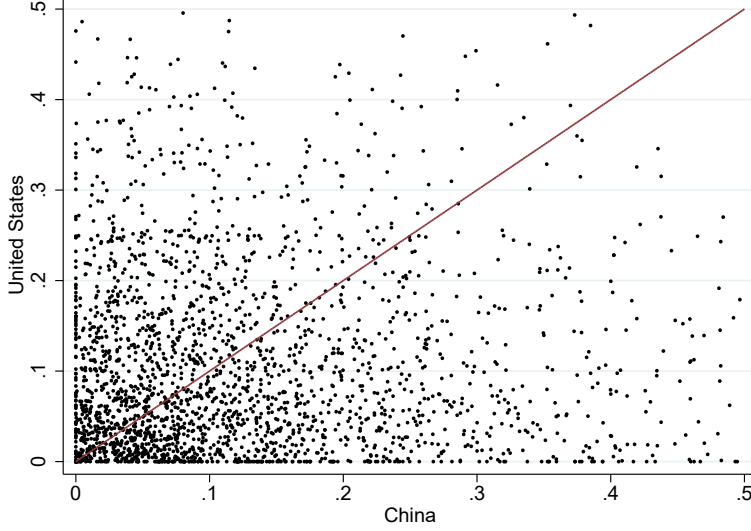
Figure 2 shows that at average $\bar{\Psi}$ (0.086), both models yield the same predicted import growth. This is consistent with the extensive literature showing the goodness of fit of the gravity equation since it suggests we could ignore this channel in some settings. When initial concentration is higher than 0.147, the hybrid model delivers significantly lower import growth. In terms of the sample employed, it means that for the top 19% exporter-industry import flows, the impact of trade liberalization will be lower than what a standard gravity equation microfounded by perfect and monopolistic competitive models would predict. In a context with rising concentration, considering the differential behavior of large firms may become increasingly necessary.

3.4.3 Differential Impact Due to Concentration

When tariffs uniformly decrease for all exporters, the model predicts that the impact will be heterogeneous depending on the initial aggregate market power of exporters. In this section I quantify the differential import growth between exporters with high and low concentration.

In Figure 3, I plot the relationship between product-specific industrial concentration in exports from China and the US to Colombia in 2007. The figure shows that this variable has substantial variation as most dots are scattered along the entire plane and do not seem to cluster around the 45 degree line.

Figure 3: Industry-level Conditional Industrial Concentration in Colombia. China vs. USA (2007).



Note: Scatter plot of HS6-specific $\Psi_{p,CH}$ (China) and $\Psi_{p,US}$ (US) in 2007. The US has more market power in products above the 45 degree line and China does in products below the 45 degree line.

In order to compare differences in industrial concentration, recall that the change in imports can be written as follows based on the decomposition of the oligopolistic margin presented in the previous section:

$$\Delta \widehat{\log M} = \Delta \log \tau \left[\widehat{\alpha^{MC}} + \widehat{\alpha^{OC}} [\Psi_{\mathcal{M}} + \Psi_{\mathcal{C}} + \Psi_{\mathcal{N}}] \right] \quad (42)$$

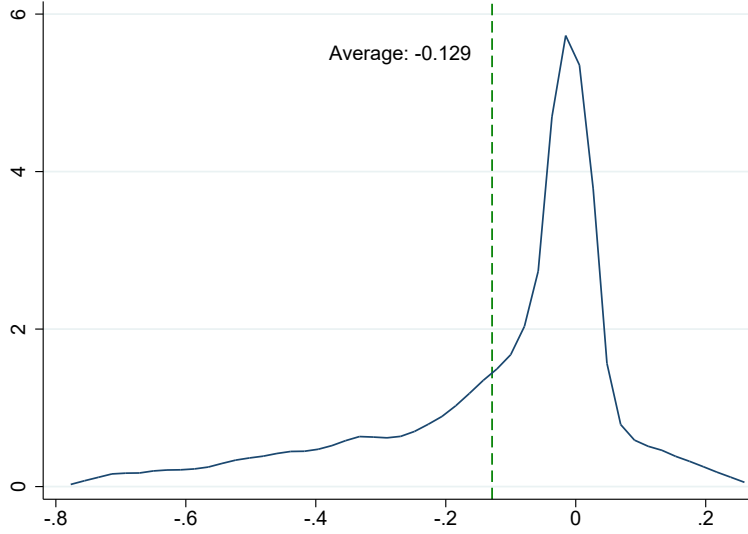
To isolate the heterogeneous impact of trade policy when there are differences in the market structure of exporters, I calculate the product-specific differential elasticity between high and low concentration exporters using the conditional concentration term $\Psi_{\mathcal{C}}$. I calculate the elasticity of exporters at the 90th percentile of $\Psi_{\mathcal{C}}$ (high concentration, HC) and the elasticity of exporters at the 10th percentile of the same variable (low concentration, LC). In order to account for potential correlation across the different components of Ψ and tariff changes, I also consider the associated $\Psi_{\mathcal{M}}$ and $\Psi_{\mathcal{N}}$, and changes in applied $\Delta \log \tau$ of high and low concentration exporters.⁵⁵

In Figure 4 I graph the empirical distribution of the differential import growth between LC and HC exporters. As it can be seen, there is a lot of heterogeneity across products and the average differential is 13 log points. This implies that the model predicts about 13% lower import growth in the case of exporters that are highly concentrated.

As a conclusion, the implicit heterogeneity across foreign exporters within products implies that decreasing tariffs to more competitive countries can increase trade at a greater extent. Therefore, policymakers should take this margin into account when predicting the outcome of discriminatory trade policy.

⁵⁵Note that if HC countries have low $\Psi_{\mathcal{M}}$ and $\Psi_{\mathcal{N}}$, the increase in the trade elasticity could be offset.

Figure 4: Differential Import Growth Distribution.



Note: Distribution of $\Delta \log \widehat{M}^{HC} - \Delta \log \widehat{M}^{LC}$ across HS6 products using baseline estimates from Table 2, Column 3.

4 Summary and Concluding Remarks

In this paper, I argued that accounting for oligopolistic behavior in trade flows is important given the high levels of concentration we observe in export data and the evidence of an increase in domestic and foreign concentration observed in the last couple of decades. I constructed a hybrid model where two types of firms, small and large relative to the market, from two origins, domestic and foreign, compete in a given market by selling varieties of the same good. Such model allowed me to derive novel implications in which I relate industrial concentration to the CES price index at the industry level.

I uncovered a new channel through which trade liberalization can affect consumer welfare: the relative industrial concentration between domestic and foreign firms. When domestic firms are relatively more concentrated, a reduction in tariffs has positive pro-competitive gains from trade because domestic granular firms relatively reduce their markup. The opposite is true when foreign firms are relatively more concentrated. The reason is that domestic concentration captures the aggregate partial elasticity of the domestic price index to competition, and foreign concentration in the domestic economy captures the aggregate partial elasticity of the import price index to competition. In this regard, concentration is microfounded by the state of competition through the distribution of markups. I show that this effect is especially strong when countries are highly integrated and the share of granular firms in the industry is large.

The model allowed me to construct a structural equation relating changes in domestic concentration to changes in competition. I showed that when there is a decrease in the industry price index (e.g. an increase in foreign competition), domestic concentration increases as measured by the *HHI* if large domestic firms have a larger market share than small domestic firms. To the best of my knowledge, this is the first theoretical equation relating concentration to international trade that can be brought to the data. This can be useful for

studying the potential relationship between the increase in import penetration from China and the increase in domestic concentration many countries have experienced. I leave this for future research.

I employed the hybrid model to derive a gravity equation in changes in a multi-country setting and showed that granular firms introduce an extra margin of adjustment into the trade cost elasticity. On top of the intensive and extensive margin, the model implies an oligopolistic margin that depends on both exporter-specific concentration and the bilateral importance of exporter-specific granular firms. This extra margin comes from large firm's markup adjustments when trade costs change. The higher exporter concentration, the lower is the impact of trade costs on import growth.

I tested the model using changes in discriminatory trade policy in Colombia. I exploited diff-in-diff variation in tariffs due to both a unilateral trade liberalization and the signature of free trade agreements over the 2010-2013 period and found robust evidence for the oligopolistic margin. Using the preferred specification, I derived quantitative implications relative to the standard gravity equation, which is microfounded under monopolistic and competitive behavior. I found that import growth is predicted to be significantly lower for the top 19% of import flows in terms of initial exporter concentration. Moreover, I found that the aggregate effect of the decrease in tariffs was lower than the average effect due to oligopolistic behavior, which suggests that further exploring the aggregate implications of this model can be an avenue for future research.

I found that imports from countries at the top decile in terms of firm concentration were predicted to have 13 log points lower growth on average than imports from countries at the bottom decile. This implies that accounting for oligopolistic behavior may be important for trade policy when there is high concentration, since gains may be lower when signing agreements with less competitive countries. Given the usual political constraints this kind of policies face, policy makers should account for this mechanism when signing trade agreements and lowering tariffs, potentially focusing on signing agreements with more competitive partners.

References

- [1] T. Allen, C. Arkolakis, and Y. Takahashi. Universal gravity. *Journal of Political Economy*, 128(2), 2020.
- [2] M. Amiti, O. Itskhoki, and J. Konings. Importers, exporters, and exchange rate disconnect. *American Economic Review*, 104(7):1942–78, 2014.
- [3] M. Amiti, O. Itskhoki, and J. Konings. International shocks, variable markups and domestic prices. *The Review of Economic Studies*, 2018.
- [4] J. E. Anderson. A theoretical foundation for the gravity equation. *American Economic Review*, 69(1):106–116, 1979.
- [5] J. E. Anderson and E. Van Wincoop. Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1):170–192, 2003.

- [6] C. Arkolakis, A. Costinot, D. Donaldson, and A. Rodríguez-Clare. The elusive pro-competitive effects of trade. *The Review of Economic Studies*, 86(1):46–80, 2018.
- [7] C. Arkolakis, A. Costinot, and A. Rodríguez-Clare. New trade models, same old gains? *American Economic Review*, 102(1):94–130, 2012.
- [8] A. Atkeson and A. Burstein. Pricing-to-market, trade costs, and international relative prices. *American Economic Review*, 98(5):1998–2031, December 2008.
- [9] R. A. Auer and R. S. Schoenle. Market structure and exchange rate pass-through. *Journal of International Economics*, 98:60–77, 2016.
- [10] D. Autor, D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen. Concentrating on the fall of the labor share. *American Economic Review*, 107(5):180–85, May 2017.
- [11] D. Autor, D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen. The fall of the labor share and the rise of superstar firms. *The Quarterly Journal of Economics*, 135(2):645–709, 2020.
- [12] S. L. Baier and J. H. Bergstrand. Do free trade agreements actually increase members’ international trade? *Journal of International Economics*, 71(1):72–95, 2007.
- [13] S. L. Baier, J. H. Bergstrand, and M. Feng. Economic integration agreements and the margins of international trade. *Journal of International Economics*, 93(2):339–350, 2014.
- [14] M. Bajgar, G. Berlingieri, S. Calligaris, C. Criscuolo, and J. Timmis. Industry concentration in europe and north america. Cep discussion papers, Centre for Economic Performance, LSE, 2019.
- [15] A. B. Bernard, J. B. Jensen, S. J. Redding, and P. K. Schott. Global firms. *Journal of Economic Literature*, 56(2):565–619, 2018.
- [16] C. Broda and D. E. Weinstein. Globalization and the gains from variety. *The Quarterly Journal of Economics*, 121(2):541–585, 2006.
- [17] T. Chaney. Distorted gravity: the intensive and extensive margins of international trade. *American Economic Review*, 98(4):1707–21, 2008.
- [18] J. De Loecker, J. Eeckhout, and G. Unger. The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics*, 135(2):561–644, 2020.
- [19] J. De Loecker, P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik. Prices, markups, and trade reform. *Econometrica*, 84(2):445–510, 2016.
- [20] S. Dhingra and J. Morrow. Monopolistic competition and optimum product diversity under firm heterogeneity. *Journal of Political Economy*, 127(1):196–232, 2019.

- [21] J. Eaton, M. Eslava, M. Kugler, and J. Tybout. Export dynamics in colombia: Firm-level evidence. Technical report, National Bureau of Economic Research, 2007.
- [22] J. Eaton, S. S. Kortum, and S. Sotelo. International trade: Linking micro and macro. Technical report, National bureau of economic research, 2012.
- [23] C. Edmond, V. Midrigan, and D. Y. Xu. Competition, markups, and the gains from international trade. *American Economic Review*, 105(10):3183–3221, 2015.
- [24] R. C. Feenstra. Restoring the product variety and pro-competitive gains from trade with heterogeneous firms and bounded productivity. *Journal of International Economics*, 110:16–27, 2018.
- [25] R. C. Feenstra and D. E. Weinstein. Globalization, markups, and us welfare. *Journal of Political Economy*, 125(4):1040–1074, 2017.
- [26] A. M. Fernandes, P. J. Klenow, S. Meleshchuk, M. D. Pierola, and A. Rodriguez-Clare. The intensive margin in trade: How big and how important?, 2019.
- [27] P. C. Ferreira and G. Facchini. Trade liberalization and industrial concentration: Evidence from brazil. *The Quarterly Review of Economics and Finance*, 45(2-3):432–446, 2005.
- [28] C. Freund and M. D. Pierola. Export superstars. *Review of Economics and Statistics*, 97(5):1023–1032, 2015.
- [29] C. Gaubert and O. Itzhoki. Granular comparative advantage. Technical report, National Bureau of Economic Research, 2018.
- [30] G. Grullon, Y. Larkin, and R. Michaely. Are US Industries Becoming More Concentrated? *Review of Finance*, 23(4):697–743, 04 2019.
- [31] G. Gutiérrez and T. Philippon. Declining competition and investment in the u.s. Working Paper 23583, National Bureau of Economic Research, July 2017.
- [32] K. Head and B. J. Spencer. Oligopoly in international trade: Rise, fall and resurgence. *Canadian Journal of Economics/Revue canadienne d’économique*, 50(5):1414–1444, 2017.
- [33] P. Krugman. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9(4):469–479, 1979.
- [34] P. Krugman. Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, 70(5):950–959, 1980.
- [35] T. Mayer and G. I. Ottaviano. The happy few: The internationalisation of european firms. *Intereconomics*, 43(3):135–148, 2008.

- [36] M. J. Melitz. The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):1695–1725, 2003.
- [37] M. J. Melitz and S. J. Redding. New trade models, new welfare implications. *American Economic Review*, 105(3):1105–46, 2015.
- [38] J. P. Neary. International trade in general oligopolistic equilibrium. *Review of International Economics*, 24(4):669–698, 2016.
- [39] OECD. *Market Concentration*. 2018.
- [40] M. Parenti. Large and small firms in a global market: David vs. goliath. *Journal of international Economics*, 110:103–118, 2018.
- [41] K.-I. Shimomura and J.-F. Thisse. Competition among the big and the small. *The Rand Journal of Economics*, 43(2):329–347, 2012.
- [42] M. Torres and G. Romero. Efectos de la reforma estructural arancelaria en la protección efectiva arancelaria de la economía colombiana. *Cuadernos de Economía*, 32(59):265–303, 2013.

A Proofs and Analytic Derivations

A.1 Analytic Derivations

A.1.1 Markups and Elasticity of Demand of Large Firms

Firms maximize their profits by choosing quantities taking into account their effect on aggregates (I omit industry subscripts).

Firms' i in r problem:

$$\max_{q_{r,i}^l} (p_{r,i}^l / \tau - c_{f,i}^l T_r) q_{f,i}^l \quad (43)$$

subject to $p_{r,i}^l = (q_{r,i}^l)^{-\frac{1}{\sigma}} Q^{\frac{1-\sigma}{\sigma}} E$.

First order condition (FOC):

$$(p_{r,i}^l)'_q q_{r,i}^l + p_{r,i}^l - c_{r,i}^l T_r \tau = 0 \quad (44)$$

where $(p_{r,i}^l)'_q = -\frac{1}{\sigma} \frac{p_{r,i}^l}{q_{r,i}^l} - \frac{\sigma-1}{\sigma} \frac{p_{r,i}^l}{Q} Q'_q$ and $Q'_q = \frac{Q}{\frac{\sigma-1}{\sigma}} (q_{r,i}^l)^{-\frac{1}{\sigma}}$.

Therefore, the FOC is:

$$-\frac{1}{\sigma}p_{r,i}^l - \frac{\sigma-1}{\sigma} \frac{p_{r,i}^l}{Q^{\frac{\sigma-1}{\sigma}}} (q_{r,i}^l)^{\frac{\sigma-1}{\sigma}} + p_{r,i}^l = c_{r,i}^l T_r \tau \quad (45)$$

Given that $s_{r,i}^l = \frac{p_{r,i}^l q_{r,i}^l}{PQ} = \frac{(q_{r,i}^l)^{\frac{\sigma-1}{\sigma}}}{Q^{\frac{\sigma-1}{\sigma}}}$, we can write the markup as a function of the market share:

$$\begin{aligned} p_{r,i}^l \left[1 - \frac{1}{\sigma} - \frac{\sigma-1}{\sigma} s_{r,i}^l \right] &= c_{r,i}^l T_r \tau \\ \frac{p_{r,i}^l}{c_{r,i}^l T_r \tau} &= \frac{\sigma}{(\sigma-1)(1-s_{r,i}^l)} \end{aligned} \quad (46)$$

The firm-specific elasticity of demand $-\nu^l$ can be derived by using the Lerner Index:

$$\begin{aligned} \frac{1}{-\nu_{r,i}^l} &= \frac{p_{r,i}^l - c_{r,i}^l T_r \tau}{p_{r,i}^l} \\ -\nu_{r,i}^l &= \frac{1}{s_{r,i}^l + (1-s_{r,i}^l)/\sigma} \end{aligned} \quad (47)$$

where it can be seen that $-\nu_{r,i}^l$ is decreasing in $s_{r,i}^l$ and therefore large firms face a more inelastic demands.

A.1.2 First Order Approximation of Ψ

The concentration measure Ψ_r can be written as follows:

$$\begin{aligned} \Psi_r &= \sum_{i=1}^{N_r} z_f^l \frac{(\sigma-1) \frac{s_{r,i}^l}{1-s_{r,i}^l}}{1 + (\sigma-1) \frac{s_{r,i}^l}{1-s_{r,i}^l}} \\ &= \sum_{i=1}^{N_r} z_r^l \frac{(\sigma-1) s_{r,i}^l}{1 + (\sigma-2) s_{r,i}^l} \end{aligned} \quad (48)$$

To construct the first order approximation around $\sigma = 2$ we need the following:

$$\Psi_r|_{\sigma=2} = s_r h_r^l \sum_{i=1}^{N_r} (z_f^l)^2 \quad (49)$$

$$\begin{aligned} \frac{\partial \Psi_r}{\partial \sigma}|_{\sigma=2} &= \sum_{i=1}^{N_r} z_r^l \left[\frac{\partial \left(\frac{(\sigma-1)s_{r,i}^l}{1+(\sigma-2)s_{r,i}^l} \right)}{\partial \sigma} \right] |_{\sigma=2} \\ &= \sum_{i=1}^{N_r} z_r^l s_{r,i}^l (1 - s_{r,i}^l) \\ &= s_r h_r^l \sum_{i=1}^{N_r} (z_r^l)^2 - s_r h_r^l \sum_{i=1}^{N_r} (z_r^l)^3 \end{aligned} \quad (50)$$

where I used $s_{r,i}^l \equiv s_r h_r^l z_r^l$. Putting all together:

$$\begin{aligned} \Psi_r &\approx \Psi_r|_{\sigma=2} + \frac{\partial \Psi_r}{\partial \sigma}|_{\sigma=2} (\sigma - 2) \\ &\approx s_r h_r^l \sum_{i=1}^{N_r} (z_r^l)^2 + \left[s_r h_r^l \sum_{i=1}^{N_r} (z_r^l)^2 s_{r,i}^l - (s_r h_r^l)^2 \sum_{i=1}^{N_r} (z_r^l)^3 \right] (\sigma - 2) \\ &\approx (\sigma - 1) s_r h_r^l \sum_{i=1}^{N_r} (z_r^l)^2 - (\sigma - 2) (s_r h_r^l)^2 \sum_{i=1}^{N_r} (z_r^l)^3 \end{aligned} \quad (51)$$

A.2 Proofs

A.2.1 Proposition 1. Relative Market Shares Response to Trade Liberalization.

The first point of the proposition implies we need to prove the following:

$$\frac{d \log z_{f,i}^l / z_{f,j}^l}{d \log \tau / P} > 0 \quad (52)$$

where $c_{f,j}^l > c_{f,i}^l$. Note that by proving for τ it can be extended to any change in the relative price of imports.

The market shares within large foreign firms are: $z_{f,i}^l = (p_{f,i}^l)^{1-\sigma} / (P_f^l)^{1-\sigma}$, therefore $d \log z_{f,i}^l = d \log (p_{f,i}^l)^{1-\sigma} - d \log (P_f^l)^{1-\sigma}$. Given that, we only need to derive $d \log (p_{f,i}^l)^{1-\sigma}$ since $d \log z_{f,i}^l - d \log z_{f,j}^l = d \log (p_{f,i}^l)^{1-\sigma} - d \log (p_{f,j}^l)^{1-\sigma}$.

$$\begin{aligned} d \log p_{f,i}^l &= d \log [\tilde{\mu} (1 - s_{f,i}^l)^{-1} c_{f,i}^l T_f \tau] \\ &= \frac{s_{f,i}^l}{1 - s_{f,i}^l} d \log s_{f,i}^l + d \log \tau \end{aligned} \quad (53)$$

where I assumed fixed $c_{f,i}^l$ and T_f . Note that $d \log s_{f,i}^l = (1 - \sigma)d \log p_{f,i}^l - (1 - \sigma)d \log P$. Therefore:

$$\begin{aligned}
d \log p_{f,i}^l &= \frac{s_{f,i}^l}{1 - s_{f,i}^l} (1 - \sigma) [d \log p_{f,i}^l - d \log P] + d \log \tau \\
&= -\psi_{f,i}^l [d \log p_{f,i}^l - d \log P] + d \log \tau \\
&= \frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log P + \frac{1}{1 + \psi_{f,i}^l} d \log \tau
\end{aligned} \tag{54}$$

where I used the definition $\psi_{f,i}^l \equiv -\frac{\partial \log \mu_{f,i}^l}{\partial \log p_{f,i}^l} = (\sigma - 1) \frac{s_{f,i}^l}{1 - s_{f,i}^l}$.

Subtract the price of the two large foreign firms:

$$\begin{aligned}
d \log p_{f,i}^l - d \log p_{f,j}^l &= \frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log P + \frac{1}{1 + \psi_{f,i}^l} d \log \tau - \frac{\psi_{f,j}^l}{1 + \psi_{f,j}^l} d \log P - \\
&\quad - \frac{1}{1 + \psi_{f,j}^l} d \log \tau \\
&= \frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log P - \frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log \tau - \frac{\psi_{f,j}^l}{1 + \psi_{f,j}^l} d \log P + \\
&\quad + \frac{\psi_{f,j}^l}{1 + \psi_{f,j}^l} d \log \tau \\
&= -\frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log \tau / P + \frac{\psi_{f,j}^l}{1 + \psi_{f,j}^l} d \log \tau / P
\end{aligned} \tag{55}$$

where in the second line I used $\frac{1}{1 + \psi_{f,i}^l} - 1 = -\frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l}$. Finally:

$$\begin{aligned}
d \log z_{f,i}^l - d \log z_{f,j}^l &= (\sigma - 1) \left[\frac{\psi_{f,i}^l}{1 + \psi_{f,i}^l} d \log \tau / P - \frac{\psi_{f,j}^l}{1 + \psi_{f,j}^l} d \log \tau / P \right] \\
&= \frac{\sigma - 1}{(1 + \psi_{f,i}^l)(1 + \psi_{f,j}^l)} \left[\psi_{f,i}^l - \psi_{f,j}^l \right] d \log \tau / P
\end{aligned} \tag{56}$$

Given that $\frac{\sigma - 1}{(1 + \psi_{f,i}^l)(1 + \psi_{f,j}^l)} > 0$, we need $\psi_{f,i}^l - \psi_{f,j}^l > 0$ which follows from the fact that $z_{f,i}^l > z_{f,j}^l$.

The second point holds symmetrically by comparing two domestic firms and noting that $\tau = 1$. The decrease in τ decreases P and then increases the ratio $z_{d,i'}^l / z_{d,j'}^l$, where $c_{d,j'}^l > c_{d,i'}^l$.

A.2.2 Proposition 2. Large Firms Price Index and Concentration.

To prove that Ψ_f^l is a proper concentration measure it suffices to show that $m(z_{f,i}; s_f) = z_{f,i}^l \frac{(\sigma - 1) \frac{s_f h_f^l z_{f,i}^l}{1 - s_f h_f^l z_{f,i}^l}}{1 + (\sigma - 1) \frac{s_f h_f^l z_{f,i}^l}{1 - s_f h_f^l z_{f,i}^l}}$

is convex in $z_{f,i}^l$, since $\Psi_f^l = \sum_{i=1}^N m(z_{f,i})$:

$$m'_{\Psi_f} = \frac{(\sigma - 1) s_f z_{f,i} ((\sigma - 2) s_f z_{f,i} + 2)}{((\sigma - 2) s_f z_{f,i} + 1)^2} \quad (57)$$

$$m''_{\Psi_f} = \frac{2(\sigma - 1) s_f}{((\sigma - 2) s_f z_{f,i} + 1)^3} > 0 \quad (58)$$

Which proves that a mean preserving spread of Ψ_f^l increases its value and therefore it is a proper firm concentration measure.

A.2.3 Proposition 3. Industry Price Index Elasticity.

Decomposition. Totally differentiating the price index I get:

$$d \log P = h^l d \log P^l + (1 - h^l) d \log P^s \quad (59)$$

where $h^l = \frac{(P^l)^{1-\sigma}}{(P^l)^{1-\sigma} + (P^s)^{1-\sigma}}$. Hence, I can derive the impact on each subset of firms and then add them up.

Large Firms. Rewriting the price index of domestic and foreign large firms directly as a function of the individual firms' prices we get:

$$d \log P^l = s_f^l d \log P_f^l + (1 - s_f^l) d \log P_d^l \quad (60)$$

$$= s_f^l \sum_{k=i}^{N_f^l} z_{f,k}^l d \log p_{f,k}^l + (1 - s_f^l) \sum_{k=i}^{N_d^l} z_{d,k}^l d \log p_{d,k}^l \quad (61)$$

where $s_f^l = \frac{(P_f^l)^{1-\sigma}}{(P_f^l)^{1-\sigma} + (P_d^l)^{1-\sigma}}$.

We already derived $d \log p_{f,k}^l = \frac{\psi_{f,k}^l}{1 + \psi_{f,k}^l} d \log P - \frac{\psi_{f,k}^l}{1 + \psi_{f,k}^l} d \log \tau$ when proving Proposition 1, thus:

$$\begin{aligned} d \log P^l &= s_f^l \sum_{k=i}^{N_f^l} z_{f,k}^l \left[\frac{\psi_{f,k}^l}{1 + \psi_{f,k}^l} d \log P + \right. \\ &\quad \left. + \frac{1}{1 + \psi_{f,k}^l} d \log \tau \right] + (1 - s_f^l) \sum_{k=i}^{N_d^l} z_{d,k}^l \frac{\psi_{d,k}^l}{1 + \psi_{d,k}^l} d \log P \\ &= s_f^l \Psi_f^l \log P + s_f^l (1 - \Psi_f^l) d \log \tau + (1 - s_f^l) \Psi_d^l d \log P \\ &= \Psi^l \log P + s_f^l (1 - \Psi_f^l) d \log \tau \end{aligned} \quad (62)$$

where I used the definition $\Psi_f^l \equiv \sum_{k=i}^{N_f^l} z_{f,k}^l \frac{\psi_{f,k}^l}{1+\psi_{f,k}^l}$, the fact that $1 - \Psi_f^l = \sum_{k=i}^{N_f^l} z_{f,k}^l \frac{1}{1+\psi_{f,k}^l}$, and I defined $\frac{\partial \log P^l}{\partial \log P} \equiv s_f^l \Psi_f^l + (1 - s_f^l) \Psi_d^l \equiv \Psi$.

Small Firms. We can analogously write the change in small firms' price index as follows:

$$d \log P^s = s_f^s d \log P_f^s + (1 - s_f^s) d \log P_d^s \quad (63)$$

where $s_f^s = \frac{(P_f^s)^{1-\sigma}}{(P_f^s)^{1-\sigma} + (P_d^s)^{1-\sigma}}$.

The foreign price index for small firms is as follows:

$$\begin{aligned} (P_f^s)^{1-\sigma} &= N \int_{c_L^s}^{c_{f,*}^s} p(c)^{1-\sigma} dG^s(j) \\ &= kN \frac{\tilde{\mu}^{1-\sigma} T_f^{1-\sigma} \tau^{1-\sigma}}{(c_H^s)^k - (c_L^s)^k} \int_{c_L^s}^{c_{f,*}^s} (c^s)^{k-\sigma} d(c^s) \\ &= kN \frac{\tilde{\mu}^{1-\sigma} T_f^{1-\sigma} \tau^{1-\sigma}}{(c_H^s)^k - (c_L^s)^k} \left[\frac{(c^s)^{k-(\sigma-1)}}{k-(\sigma-1)} \right]_{c_L^s}^{c_{f,*}^s} \\ &= kN \frac{\tilde{\mu}^{1-\sigma} T_f^{1-\sigma} \tau^{1-\sigma}}{(c_H^s)^k - (c_L^s)^k} \left[\frac{(c_{f,*}^s)^{k-(\sigma-1)} - (c_L^s)^{k-(\sigma-1)}}{k-(\sigma-1)} \right] \end{aligned} \quad (64)$$

where I need that $k - (\sigma - 1) > 0$ to have a well-defined Pareto distribution of sales.

Differentiating this expression yields:

$$d \log (P_f^s)^{1-\sigma} = (1 - \sigma) d \log \tau + \lambda_f^s d \log c_{f,*}^s \quad (65)$$

where $\lambda_f = (k - (\sigma - 1)) \frac{(c_{f,*}^s)^{k-(\sigma-1)}}{(c_{f,*}^s)^{k-(\sigma-1)} - (c_L^s)^{k-(\sigma-1)}}$ is the hazard function of foreign sales distribution under bounded Pareto. Since $c_{f,*}^s = \frac{P}{T_f} \left[\frac{\tilde{\sigma} E}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \tau^{-\frac{\sigma}{\sigma-1}}$ we have:

$$\begin{aligned} d \log (P_f^s)^{1-\sigma} &= (1 - \sigma) d \log \tau + \lambda_f^s d \log \left[\frac{P}{T_f} \left[\frac{\tilde{\sigma} E}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \tau^{-\frac{\sigma}{\sigma-1}} \right] \\ &= (1 - \sigma) d \log \tau + \lambda_f^s d \log P - \lambda_f^s \frac{\sigma}{\sigma-1} d \log \tau \\ &= \lambda_f^s d \log P - (\sigma - 1) \left[1 + \frac{\lambda_f^s}{\sigma-1} \frac{\sigma}{\sigma-1} \right] d \log \tau \end{aligned} \quad (66)$$

where I assumed exogenous T_f and E . The small domestic firms price index is analogous but without the direct tariff impact. Therefore, both effects are:

$$d \log P_f^s = -\Lambda_f^s d \log P + \left[1 + \Lambda_f^s \frac{\sigma}{\sigma-1} \right] d \log \tau \quad (67)$$

$$d \log P_d^s = -\Lambda_d^s d \log P \quad (68)$$

where I defined $\Lambda_f^s \equiv \frac{\lambda_f^s}{\sigma-1}$ as in the text.

Therefore, the total impact of small firms is:

$$\begin{aligned} d \log P^s &= s_f^s \left[-\Lambda_f^s d \log P + \left[1 + \Lambda_f^s \frac{\sigma}{\sigma-1} \right] d \log \tau \right] + (1 - s_f^s) \left[-\Lambda_d^s d \log P \right] \\ &= -\Lambda^s d \log P + s_f^s \left[1 + \Lambda_f^s \frac{\sigma}{\sigma-1} \right] d \log \tau \end{aligned} \quad (69)$$

where $\Lambda^s \equiv s_f^s \Lambda_f^s + (1 - s_f^s) \Lambda_d^s$.

Total Impact. To derive the total impact of τ on P we put together previous derivations:

$$\begin{aligned} d \log P &= h^l \left[\Psi^l d \log P + s_f^l (1 - \Psi_f^l) d \log \tau \right] + \\ &+ (1 - h^l) \left[-\Lambda^s d \log P + s_f^s (1 + \Lambda_f^s \frac{\sigma}{\sigma-1}) d \log \tau \right] \\ &= \left[h^l \Psi^l - (1 - h^l) \Lambda^s \right] d \log P + \\ &+ \left[h^l s_f^l (1 - \Psi_f^l) + (1 - h^l) s_f^s (1 + \Lambda_f^s \frac{\sigma}{\sigma-1}) \right] d \log \tau \end{aligned} \quad (70)$$

Defining $H \equiv 1 - h^l \Psi^l + (1 - h^l) \Lambda^s$ yields:

$$\frac{d \log P}{d \log \tau} = \frac{h^l s_f^l (1 - \Psi_f^l) + (1 - h^l) s_f^s (1 + \Lambda_f^s \frac{\sigma}{\sigma-1})}{H} \quad (71)$$

Decomposition. We can write the pride index elasticity as follows:

$$\frac{d \log P}{d \log \tau} = \Theta^l + \Theta^s \quad (72)$$

where $\Theta^l \equiv \frac{h^l s_f^l (1 - \Psi_f^l)}{H}$ and $\Theta^s \equiv \frac{(1 - h^l) s_f^s (1 + \tilde{\Lambda}_f^s)}{H}$, and $\tilde{\Lambda}_f^s \equiv \Lambda_f^s \frac{\sigma}{\sigma-1}$. Then, we can work on each term of the elasticity:

$$\begin{aligned}
\Theta^l &= \frac{h^l s_f^l}{H} - \frac{h^l s_f^l \Psi_f^l}{H} \\
&= h^l s_f^l + \frac{h^l s_f^l}{H}(1-H) - \frac{h^l s_f^l \Psi_f^l}{H} \\
&= h^l s_f^l + \frac{h^l s_f^l}{H}(h^l \Psi^l - h^l \Psi_f^l + h^l \Psi_f^l - (1-h^l)\Lambda^s) - \frac{h^l s_f^l \Psi_f^l}{H} \\
&= h^l s_f^l + (h^l)^2 \frac{s_f^l(1-s_f^l)}{H}(\Psi_d^l - \Psi_f^l) - s_f^l \frac{h^l(1-h^l)}{H}(\Psi_f^l + \Lambda^s)
\end{aligned} \tag{73}$$

$$\begin{aligned}
\Theta^s &= \frac{(1-h^l)s_f^s(1+\tilde{\Lambda}_f^s)}{H} \\
&= (1-h^l)s_f^s + \frac{(1-h^l)s_f^s}{H}(1-H) + \frac{(1-h^l)s_f^s\tilde{\Lambda}_f^s}{H} \\
&= (1-h^l)s_f^s + \frac{(1-h^l)^2 s_f^s}{H}(\Lambda_f^s - \Lambda^s) - \frac{(1-h^l)s_f^s}{H}(1-h^l)\Lambda_f^s + \\
&\quad + \frac{(1-h^l)s_f^s}{H}h^l\Psi^l + \frac{(1-h^l)s_f^s\tilde{\Lambda}_f^s}{H} \\
&= (1-h^l)s_f^s + \frac{(1-h^l)^2 s_f^s}{H}(\Lambda_f^s - s_f^s\Lambda_f^s - (1-s_f^s)\Lambda_d^s) + \\
&\quad + \frac{(1-h^l)s_f^s}{H}(\tilde{\Lambda}_f^s - (1-h^l)\Lambda_f^s + h^l\Psi^l) \\
&= (1-h^l)s_f^s + (1-h^l)^2 \frac{s_f^s(1-s_f^s)}{H}(\tilde{\Lambda}_f^s - \tilde{\Lambda}_d^s) + \\
&\quad + s_f^s \frac{(1-h^l)h^l}{H}(a\Lambda_f^s + \Psi^l)
\end{aligned} \tag{74}$$

where $a \equiv \frac{h^l(\sigma-1)+1}{h^l(\sigma-1)}$. Adding both terms yields the final result:

$$\begin{aligned}
\frac{d \log P}{d \log \tau} &= s_f + (h^l)^2 \frac{s_f^l(1-s_f^l)}{H}(\Psi_d^l - \Psi_f^l) + (1-h^l)^2 \frac{s_f^s(1-s_f^s)}{H}(\Lambda_f^s - \Lambda_d^s) + \\
&\quad + \frac{(1-h^l)h^l}{H} \left[s_f^s(1-s_f^l)[\Psi_d^l + b\Lambda_f^s] - (1-s_f^s)s_f^l[\Psi_f^l + \Lambda_d^s] \right]
\end{aligned} \tag{75}$$

where $b \equiv \frac{a-s_f^l}{1-s_f^l}$. Note that $b = 1$ in the case of $\frac{d \log P}{d \log T_f}$ because the cost cutoff elasticity with respect to the price index and trade costs is the same.

Sign. This result follows directly from equation 71. We can further reduced it by noting that $h^l s_f^l = s_f h_f^l$ and hence $h^l s_f^l + (1-h^l)s_f^s = s_f$:

$$\frac{d \log P}{d \log \tau} = s_f \frac{\tilde{H}_f}{H} \tag{76}$$

where $\tilde{H}_f \equiv 1 - h_f^l \Psi_f^l + (1-h_f^l)\Lambda_f^s \frac{\sigma}{\sigma-1}$.

Given that $1 - h^l \Psi^l$ and $1 - h_f^l \Psi_f^l$ are both positive because both h^l and Ψ^l are between zero and one, this expression is always negative.

In terms of the upper bound, note that we can be write the elasticity as follows:

$$\frac{d \log P}{d \log \tau} = \frac{s_f H_f}{s_f H_f + (1 - s_f) H_d} + \frac{(1 - h_f^l) \Lambda_f^l}{(\sigma - 1) H} \quad (77)$$

where $H_r \equiv 1 - h_r^l \Psi_r^l + (1 - h_r^l) \Lambda_r^s$ and the last term corrects for the fact that tariffs are paid by consumers, not producers. In the potential extreme case in which there are only foreign small firms we have that:

$$1 + \frac{\Lambda_f^l}{(\sigma - 1)(1 + \Lambda_f^l)} = \frac{\sigma}{\sigma - 1} - \frac{1}{(\sigma - 1)(1 + \Lambda_f^l)} \quad (78)$$

because in this case $H = H_f = 1 + \Lambda_f^l$ and $h_f^l = 0$. Given that $\Lambda_f^l \in (0, +\infty)$, then $\frac{d \log P}{d \log \tau}$ cannot take values higher than $\frac{\sigma}{\sigma - 1}$.

Note that in the case of the price index elasticity relative to trade costs paid by producers, T_f , the upper bound is 1 because the last term in equation 77 is not present.

A.2.4 Proposition 4. Domestic Concentration and Competition.

Decomposition. In order to prove part (a) of this proposition, I will employ any proper concentration measure increasing in market shares \mathcal{C} , noting the special case of homogeneous concentration functions $\mathcal{C}_h = \sum_{i=1}^{N_d^l} (z_{d,i}^l)^t$, with $t > 1$. When $t = 2$ then $\mathcal{C}_h = HHI$.

Let's start by the general definition of \mathcal{C} :

$$\mathcal{C}^l(\{z_{d,i}\}_{i=1}^N) = \sum_{i=1}^N m(z_{d,i}; W_d) \quad (79)$$

where $m(z_{d,i}; W_d)$ is a function of internal market shares $z_{d,i}$ and can contain other factors, which I summarize in W_d . The theoretical version of it needs to consider the continuum of small firms. Hence, the full concentration measure is:

$$\mathcal{C}(\{z_{d,i}\}_{i=1}^N) = \sum_{i=1}^{N_d} m[h_d^l z_{d,i}^l] + \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l) z^s(j)] dG^s(j) \quad (80)$$

Large Firms.

$$\begin{aligned}
d \log \left[\sum_{i=1}^N m[h_d^l z_{d,i}^l] \right] &= \sum_{i=1}^N \gamma_{d,i}^l \iota_i^l [d \log z_{d,i}^l + d \log h_d^l] \\
&= \sum_{i=1}^{N_d} \gamma_{d,i}^l \iota_i^m d \log z_{d,i}^l + \iota^{m,l} d \log h_d^l
\end{aligned} \tag{81}$$

where $\gamma_{d,i}^l = \frac{m[h_d^l z_{d,i}^l]}{\sum_{k=1}^{N_d} m[h_d^l z_{d,k}^l]}$ are \mathcal{C} -specific weights and $\iota_i^m = \frac{m'_i h_d^l z_{d,i}^l}{m_i}$ is the elasticity of m with respect to the domestic market share of i , where I define $\iota^{m,l} = \sum_{i=1}^{N_d} \gamma_{d,i}^l \iota_i^m$ to be the weighted elasticity of changes in the large firm aggregate market share.

The first term captures reallocation within large firms:

$$\begin{aligned}
\sum_{i=1}^{N_d} \gamma_{d,i}^l \iota_i^m d \log z_{d,i}^l &= \sum_{i=1}^{N_d} \gamma_{d,i}^l \iota_i^m \left[d \log (p_{d,i}^l)^{1-\sigma} - d \log (P_d^l)^{1-\sigma} \right] \\
&= (1-\sigma) \sum_{i=1}^{N_d} \gamma_{d,i}^l \iota_i^m d \log p_{d,i}^l - \iota^{m,l} (1-\sigma) \sum_{i=1}^{N_d} z_{d,i}^l d \log p_{d,i}^l \\
&= (1-\sigma) \iota^{m,l} \sum_{i=1}^{N_d} \left[\tilde{\gamma}_{d,i}^l - z_{d,i}^l \right] d \log p_{d,i}^l
\end{aligned} \tag{82}$$

where $\tilde{\gamma}_{d,i}^l \equiv \gamma_{d,i}^l \frac{\iota_i^m}{\iota^{m,l}} \in (0, 1)$.

Assuming that the concentration function is homogeneous of degree t simplifies this expression due to the following:

$$\iota_i^m = \frac{m'_i h_d^l z_{d,i}^l}{m_i} = \frac{(h_d^l z_{d,i}^l)^{t-1} h_d^l z_{d,i}^l}{(h_d^l z_{d,i}^l)^t} = t$$

and implies $\iota^{m,l} = t$ and $\tilde{\gamma}_{d,i}^l = \gamma_{d,i}^l = \frac{z_{d,i}^t}{\sum_{k=1}^{N_d} z_{d,k}^t}$. As a result, the term for large firms is $t(1-\sigma) \sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i}^l \right] d \log p_{d,i}^l$ in the case of \mathcal{C}_h .

Small Firms. Small firms are atomistic so the effect of competition on concentration acts through changes in the productivity distribution of firms that enter.

$$\begin{aligned}
& \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)z(j)]dG^s(j) = \\
& = \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)z(j)]d\left[\frac{(c^s)^k - (c_L^s)^k}{(c_H^s)^k - (c_L^s)^k}\right] \\
& = \frac{k}{(c_H^s)^k - (c_L^s)^k} \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)\frac{p(c)^{1-\sigma}}{(P_d^s)^{1-\sigma}}](c^s)^{k-1}d(c^s)
\end{aligned} \tag{83}$$

At this point I assume that m is homogeneous of degree t , which means that $m[\frac{p(c)^{1-\sigma}}{P_d^{1-\sigma}}] = [\frac{p(c)^{1-\sigma}}{P_d^{1-\sigma}}]^t$.

$$\begin{aligned}
& \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)z(j)]dG^s(j) = \\
& = \frac{k}{(c_H^s)^k - (c_L^s)^k} \int_{c_L^s}^{c_{d,*}^s} m[\frac{p(c)^{1-\sigma}}{P_d^{1-\sigma}}](c^s)^{k-1}d(c^s) \\
& = \frac{k}{(c_H^s)^k - (c_L^s)^k} \frac{(1 - h_d^l)^t}{(P_d^s)^{t(1-\sigma)}} \int_{c_L^s}^{c_{d,*}^s} p(c)^{t(1-\sigma)}(c^s)^{k-1}d(c^s) \\
& = \frac{k(1 - h_d^l)^t}{(c_H^s)^k - (c_L^s)^k} \frac{\tilde{\mu}^{t(1-\sigma)}T_d^{t(1-\sigma)}}{(P_d^s)^{t(1-\sigma)}} \int_{c_L^s}^{c_{d,*}^s} (c^s)^{t(1-\sigma)+k-1}d(c^s) \\
& = \frac{k(1 - h_d^l)^t}{(c_H^s)^k - (c_L^s)^k} \frac{\tilde{\mu}^{t(1-\sigma)}T_d^{t(1-\sigma)}}{(P_d^s)^{t(1-\sigma)}} \left[\frac{(c_{d,*}^s)^{k-t(\sigma-1)} - (c_L^s)^{k-t(\sigma-1)}}{k - t(\sigma - 1)} \right]
\end{aligned} \tag{84}$$

where I need that $k - t(\sigma - 1) > 0$ to have a well-defined Pareto distribution of sales to the power of t .

Taking logs and differentiating this expression yields:

$$\begin{aligned}
d \log \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)z(j)]dG^s(j) &= td \log(1 - h_d^l) + \lambda_{t,d}^s d \log P + \\
&+ t(\sigma - 1)d \log P_d^s
\end{aligned} \tag{85}$$

where $\lambda_{t,d}^s \equiv [k - t(\sigma - 1)] \frac{c_{d,*}^{k-t(\sigma-1)}}{c_{d,*}^{k-t(\sigma-1)} - c_L^{k-t(\sigma-1)}}$ and I used that $d \log c_{d,*}^s = d \log P$.

Given that $(1 - \sigma)d \log P_d^s = \lambda_d^s d \log c_{d,*}^s$ we get:

$$d \log \int_{c_L^s}^{c_{d,*}^s} m[(1 - h_d^l)z(j)]dG^s(j) = td \log(1 - h_d^l) + [\lambda_{t,d}^s - t\lambda_d^s]d \log P \tag{86}$$

Total Impact. Adding up both derivations in the case of homogeneous concentration functions yields:

$$\begin{aligned}
d \log \mathcal{C}_h &= t(1 - \sigma) \sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i} \right] \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} d \log P + \\
&+ [\lambda_{t,d}^s - t\lambda_d^s] d \log P + t \frac{1 - 2h_d^l}{1 - h_d^l} d \log h_d^l
\end{aligned} \tag{87}$$

where I used $d \log p_{d,i}^l = \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} d \log P$.

The change in $\log h_d^l$ captures the reallocation of market share between large and small firms and is as follows:

$$\begin{aligned}
d \log h_d^l &= (1 - \sigma) \left[\sum_{i=1}^{N_d} z_{d,i} d \log p_{d,i} - d \log P_d \right] \\
&= (1 - \sigma) \Psi_d^l d \log P - (1 - \sigma) h_d^l d \log P_d^l - (1 - \sigma)(1 - h_d^l) d \log P_d^s \Big] \\
&= (1 - h_d^l)(1 - \sigma) [\Psi_d^l + \Lambda_d^s] d \log P
\end{aligned} \tag{88}$$

Replacing this last derivation into the main expression and rearranging yields the result:

$$\begin{aligned}
\frac{d \log \mathcal{C}_h}{d \log P} &= t(1 - \sigma) \sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i} \right] \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} + [\lambda_{t,d}^s - t\lambda_d^s] + \\
&+ t(1 - 2h_d^l)(1 - \sigma) [\Psi_d^l + \Lambda_d^s]
\end{aligned} \tag{89}$$

Setting $t = 2$ yields $\frac{d \log HHI}{d \log P}$ in text.

Sign. I follow the same approach than in the proof of Proposition 4 where I use any concentration measure homogeneous of degree t and note that the HHI is a special case when $t = 2$.

Sign of the Large Firms Effect. I need to prove that $\sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i} \right] \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} > 0$ which means that the sign of the large firms effect is negative (since it is multiplied by $(1 - \sigma)$).

(1) First, I need to show that there exists a firm i^* above which $\gamma_i - z_i > 0$. For any i , we can write it as follows:

$$\begin{aligned}
\gamma_i - z_i &= \frac{z_i^t}{\sum_{j=1}^N z_j^t} - z_i \\
&= \frac{\omega_i z_i}{\sum_{j=1}^N \omega_j z_j} - z_i
\end{aligned} \tag{90}$$

where $\omega_i = \frac{z_i^{t-1}}{\sum_{j=1}^N z_j^{t-1}}$ are weights that put more weight on larger firms given that $t > 1$. Define $\bar{\omega} = 1/N$ as the particular case for which all shares are equally weighted. Given that $\sum_{j=1}^N z_j = 1$, we can write it as:

$$\gamma_i - z_i = \frac{\omega_i z_i}{\sum_{j=1}^N \omega_j z_j} - \frac{\bar{\omega} z_i}{\sum_{j=1}^N \bar{\omega} z_j} \quad (91)$$

This expression shows that it is the difference of the contribution of observation i between using ω_i and $\bar{\omega}$ weights.

I claim there is a i^* such that:

- (i) $\gamma_i - z_i \geq 0$ if $i^* \geq i$
- (ii) $\gamma_i - z_i < 0$ if $i^* < i$

To prove claim (i), assume that $i \geq i^*$ and $\gamma_i - z_i < 0$:

$$\frac{\omega_i z_i}{\sum_{j=1}^N \omega_j z_j} < \frac{\bar{\omega} z_i}{\sum_{j=1}^N \bar{\omega} z_j} \quad (92)$$

but given that ω_i is increasing in z_i , then the contribution of $i > i^*$ has to be higher for these weights. Thus, $\gamma_i - z_i > 0$ for $i > i^*$.

To prove claim (ii), we can follow the same logic assuming that $i < i^*$ and $\gamma_i - z_i \geq 0$:

$$\frac{\omega_i z_i}{\sum_{j=1}^N \omega_j z_j} \geq \frac{\bar{\omega} z_i}{\sum_{j=1}^N \bar{\omega} z_j} \quad (93)$$

but given that ω_i is increasing in z_i , then the contribution of $i < i^*$ has to be lower for these weights. Thus, $\gamma_i - z_i \leq 0$ for $i < i^*$.

(2) Define $X_i = \frac{\psi_{d,i}^l}{1+\psi_{d,i}^l}$ and $Z_i = \gamma_{d,i}^l - z_{d,i}^l$. Define two sets of firms: A for firms such as $i^* \geq i$ and B for firm such as $i^* > i$. Since X_i is increasing in z_i then $X_i^B > X_j^A$ for any $i \in A$ and $j \in B$. Lets assume that the expression is negative:

$$Z^A \sum_{i \in A} Z_i^A X_i + Z^B \sum_{i \in B} Z_i^B X_i < 0 \quad (94)$$

where $Z^A = \sum_{i \in A} Z_i$, $Z^B = \sum_{i \in B} Z_i$, and $Z_i^A = Z_i/Z^A$ and $Z_i^B = Z_i/Z^B$. Note that $Z^A + Z^B = 0$ and thus:

$$\begin{aligned}
-Z^B \sum_{i \in A} Z_i^A X_i + Z^B \sum_{i \in B} Z_i^B X_i &< 0 \\
Z^B \sum_{i \in B} Z_i^B X_i &< Z^B \sum_{i \in A} Z_i^A X_i \\
\sum_{i \in B} Z_i^B X_i &< \sum_{i \in A} Z_i^A X_i
\end{aligned} \tag{95}$$

The left hand side is a weighted average of all X_i in B and the right hand side is a weighted average of all X_i in A . Since we assumed that $X_i^B > X_j^A$ for any $i \in A$ and $j \in B$ we arrived to a contradiction. Therefore:

$$Z^A \sum_{i \in A} Z_i^A X_i + Z^B \sum_{i \in B} Z_i^B X_i > 0 \tag{96}$$

which proves that $(1 - \sigma)t \sum_{i=1}^{N_d} \left[\gamma_{d,i}^l - z_{d,i} \right] \frac{\psi_{d,i}^l}{1 + \psi_{d,i}^l} < 0$.

Sign of the Small Firms Effect. Assume the sign is positive:

$$\begin{aligned}
\lambda_{t,d}^s - t\lambda_d^s &> 0 \\
t\lambda_d^s \left(\frac{\lambda_{t,d}^s}{t\lambda_d^s} - 1 \right) &> 0 \\
\frac{\lambda_{t,d}^s}{t\lambda_d^s} - 1 &> 0 \\
\frac{(c_{d,*}^s)^{k-t(\sigma-1)}}{(c_{d,*}^s)^{k-t(\sigma-1)} - (c_L^s)^{k-t(\sigma-1)}} \frac{k-t(\sigma-1)}{tk-t(\sigma-1)} &> 1 \\
\frac{1-v^{k-(\sigma-1)}}{1-v^{k-t(\sigma-1)}} \frac{k-t(\sigma-1)}{tk-t(\sigma-1)} &> 1
\end{aligned} \tag{97}$$

where $v \equiv \frac{c_L^s}{c_{d,*}^s} \in (0, 1)$. This means we can define the LHS as the function $\mathcal{F}(t; \sigma, k, v)$ and given that

$t \in (1, \infty)$, check the limit of \mathcal{F} at both boundaries:

$$\begin{aligned}
\lim_{t \rightarrow \infty} \mathcal{F}(t; \sigma, k, v) &= \lim_{t \rightarrow \infty} \left[\frac{1 - v^{k-(\sigma-1)}}{1 - v^{k-t(\sigma-1)}} \frac{k - t(\sigma-1)}{tk - t(\sigma-1)} \right] \\
&= \lim_{t \rightarrow \infty} \left[\frac{1 - v^{k-(\sigma-1)}}{1 - v^{k-t(\sigma-1)}} \right] \lim_{t \rightarrow \infty} \left[\frac{\frac{k}{t} - (\sigma-1)}{k - (\sigma-1)} \right] \\
&= \frac{1 - v^{k-(\sigma-1)}}{k - (\sigma-1)} \lim_{t \rightarrow \infty} \frac{\frac{k}{t} - (\sigma-1)}{(1 - v^{k-t(\sigma-1)})} \\
&= 0
\end{aligned} \tag{98}$$

where the last result follows from $\lim_{t \rightarrow \infty} \frac{k}{t} = 0$ and $\lim_{t \rightarrow \infty} v^{k-t(\sigma-1)} = \infty$. This means that as t increases the impact of P on small firms concentration is negative because the inequality 97 is a contradiction.

When $t \rightarrow 1^+$, we have:

$$\lim_{t \rightarrow 1^+} \mathcal{F}(t; \sigma, k, v) = 1 \tag{99}$$

Therefore, if $\frac{d\mathcal{F}}{dt} < 0$ for all $t \in (1, \infty)$, the inequality 97 is contradiction for all t in its support:

$$\frac{d\mathcal{F}}{dt} = \frac{1 - v^{k-(\sigma-1)}}{k - (\sigma-1)} \frac{d \left[\frac{\frac{k}{t} - (\sigma-1)}{(1 - v^{k-t(\sigma-1)})} \right]}{dt} < 0 \tag{100}$$

where the sign follows from $\frac{1 - v^{k-(\sigma-1)}}{k - (\sigma-1)} > 0$ and $\frac{d \left[\frac{\frac{k}{t} - (\sigma-1)}{(1 - v^{k-t(\sigma-1)})} \right]}{dt} < 0$. Therefore, 97 is a contradiction for all the support and hence the sign of the small firms effect is negative. Note that this includes $t = 2$, the *HHI* particular case.

Sign of the Cross-Effect. The sign of the cross-size effect depends on the relative market share between small domestic and large firms. If we assume that large domestic firms have more than half of the market ($h_d^l > \frac{1}{2}$), then this term is negative because both Ψ_d^l and Λ_d^s are positive.

Overall sign. The large and small firms' effects are negative. Given that the cross-size effect is positive if $h_d^l < \frac{1}{2}$, then having $h_d^l \geq \frac{1}{2}$ is sufficient to have a negative overall effect.

A.2.5 Proposition 5. Oligopoly-Augmented Gravity Equation and Partial Trade Elasticity.

We can write total exports from c to d as follows:

$$M_{cd} = M_{cd}^l + M_{cd}^s \tag{101}$$

Log-differentiating this equation yields:

$$d \log M_{cd} = h_{cd}^l d \log M_{cd}^l + (1 - h_{cd}^l) d \log M_{cd}^s \quad (102)$$

I proceed by deriving each term separately.

Large Firms. The change in total imports of large firms' varieties can be calculated as the change in the expenditure share given the exogeneity of E :

$$\begin{aligned} d \log M_{cd}^l &= (1 - \sigma) \left[\frac{\partial \log P_{cd}^l}{\partial \log \tau_{cd}} d \log \tau_{cd} + \frac{\partial \log P_{cd}^l}{\partial \log T_{cd}} d \log T_{cd} + \frac{\partial \log P_{cd}^l}{\partial \log P_d} d \log P \right] - \\ &\quad - d \log P_d^{1-\sigma} + d \log E_d \\ &= (1 - \sigma)(1 - \Psi_{cd}^l) \left[d \log \tau_{cd} + d \log T_{cd} - d \log P_d \right] + d \log E_d \end{aligned} \quad (103)$$

given that $\frac{\partial \log P_{cd}^l}{\partial \log \tau_{cd}} = \frac{\partial \log P_{cd}^l}{\partial \log T_{cd}} = (1 - \Psi_{cd}^l)$ and $\frac{\partial \log P_{cd}^l}{\partial \log P_d} = \Psi_{cd}^l$ as shown in Proposition 1.

Small Firms. To derive total imports of small firms' varieties, which includes entry, we need to calculate M_f^s by integrating over the support of c .

$$\begin{aligned} M_{cd}^s &= N_{cd}^s \int_{c_L^s}^{c_{cd*}^s} E_d P_d^{\sigma-1} (p^s(c))^{1-\sigma} dG^s(c^s) \\ &= k \frac{N_{cd}^s E_d P_d^{\sigma-1} \tau_{cd}^{1-\sigma} T_{cd}^{1-\sigma} \tilde{\mu}^{1-\sigma}}{(c_H^s)^k - (c_L^s)^k} \int_{c_L^s}^{c_{cd*}^s} (c^s)^{k-\sigma} dc \\ &= k \frac{N_{cd}^s E_d P_d^{\sigma-1} \tau_{cd}^{1-\sigma} T_{cd}^{1-\sigma} \tilde{\mu}^{1-\sigma}}{k - \sigma + 1} \left[\frac{(c_{cd*}^s)^{k-\sigma+1} - (c_L^s)^{k-\sigma+1}}{(c_H^s)^{k-\sigma+1} - (c_L^s)^{k-\sigma+1}} \right] \end{aligned} \quad (104)$$

Differentiating this equation and using $c_{cd*}^s = \frac{P_d}{T_{cd}} \left[\frac{\tilde{\sigma} E_d}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \tau_{cd}^{-\frac{\sigma}{\sigma-1}}$ we get:

$$\begin{aligned} d \log M_{cd}^s &= (1 - \sigma) \left[1 + \Lambda_{cd}^s \right] \left[d \log T_{cd} + \frac{\sigma}{\sigma - 1} d \log \tau_{cd} - d \log P_d \right] + \\ &\quad + \left[1 + \Lambda_{cd}^s \right] d \log E_d + d \log N_{cd} \end{aligned} \quad (105)$$

All Firms. Using equation 102 I get:

$$\begin{aligned}
d \log M_{cd} &= (1 - \sigma) \left[1 + (1 - h_{cd}^l) \Lambda_{cd}^s - h_{cd}^l \Psi_{cd}^l \right] \left[d \log T_{cd} + \frac{\sigma}{\sigma - 1} d \log \tau_{cd} - \right. \\
&\quad \left. - d \log P_d \right] \\
&+ \left[1 + (1 - h_{cd}^l) \Lambda_{cd}^s \right] d \log E_d + (1 - h_{cd}^l) d \log N_{cd}
\end{aligned} \tag{106}$$

Where it can be seen that:

$$\theta_{cd}^{HC} \equiv \frac{\partial \log M_{cd}}{\partial \log T_{cd}} = (1 - \sigma) \left[1 + (1 - h_{cd}^l) \Lambda_{cd}^s - h_{cd}^l \Psi_{cd}^l \right] \tag{107}$$

$$\theta_{cd}^{HC, \tau} \equiv \frac{\partial \log M_{cd}}{\partial \log \tau_{cd}} = (1 - \sigma) \left[1 + (1 - h_{cd}^l) \Lambda_{cd}^s \frac{\sigma}{\sigma - 1} - h_{cd}^l \Psi_{cd}^l \right] \tag{108}$$